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TRANDESNF: A Computer Program for Transonic Airfoil Design and Analysis in Nonuniform Flow

J. F. Chang and C. Edward Lan

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J. F. Chang and C. Edward Lan
The University of Kansas Center for Research, Inc.
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INTRODUCTION

In this report, the usage of a transonic airfoil code for analysis, inverse design, and direct optimization of an airfoil immersed in propfan slipstream is described. For a detailed description of the theory, Reference 1 should be consulted.

In the following, a summary of the theoretical method, program capabilities, input format, output variables, and program execution are described. Input data of sample test cases and the corresponding output are given.

SUMMARY OF THE THEORETICAL METHOD

In the present method, the Euler equation is simplified by introducing a velocity function Φ and a rotation function F. The latter is to account for the effect of flow nonuniformity, while the former is similar to the total velocity potential in the potential flow theory. The resulting equation can be shown to be (Ref. 1)

$$(a^2 - u^2)\Phi_{xx} - 2uv\Phi_{xy} + (a^2 - v^2)\Phi_{yy} = uvF_y - (a^2 - u^2)F_x \qquad (1)$$

where a is the local speed of sound and u, v are total velocity components in the x and y directions, respectively. Since the left-hand side of Equation (1) is the same as the full potential equation, it is convenient to modify an existing full-potential transonic airfoil code to solve the present problem. For this purpose, Carlson's code (Ref. 2) was chosen. The method of Reference 2 is based on a finite-difference approximation of Equation (1) in a Cartesian coordinate system. The finite-difference equations are solved by column relaxation. In the present problem, the rotation function and the stream function are also determined in the relaxation process.

To design an airfoil by direct optimization, the airfoil shape is expressed in a Fourier cosine series internally in the code with the Fourier coefficients being the design variables. Optimization of lift-to-drag ratio is accomplished by using CONMIN optimizer (Ref. 3) with lift and trailing-edge closure constraints.

PROGRAM CAPABILITIES

This program has the following features:

(1) It is applicable to the analysis, inverse design, and direct optimization of an airfoil in a transonic uniform or nonuniform flow. Boundary layer calculation may be included.

(2) The nonuniformity may be prescribed in the form of freestream Mach profile and/or temperature profile.

(3) The airfoil may be located vertically at any place in the nonuniform region.

INPUT DATA FORMAT

*** ALL INPUT DATA ARE IN THE LIST-DIRECTED FORMAT. ***

GROUP 1: CASE DESCRIPTION

TITLE: DESCRIPTION OF THE RUN CASE

GROUP 2: READ INPUT OPTION

IOPT EXECUTION OPTION:
- = 1 ANALYSIS OR INVERSE DESIGN
- = 2 PLOT LINEAR, NOT AVAILABLE IN THIS VERSION
- = 3 PLOT CONTOUR, NOT AVAILABLE IN THIS VERSION
- = 4 OPTIMIZE
- = 5 OPTIMIZE WITH PLOTS, NOT AVAILABLE IN THIS VERSION

IF IOPT = 1, SKIP GROUPS 3-15.

GROUPS 3-15 ARE CONMIN PARAMETERS (SEE REF. 3).

GROUP 3:

IPRINT
- = 0 PRINT NOTHING
- = 1 PRINT INITIAL AND FINAL INFORMATION
- = 2 FIRST DEBUG LEVEL
- = 3 SECOND DEBUG LEVEL
- = 4 COMPLETE DEBUG

ITMAX MAXIMUM NUMBER OF ITERATIONS IN THE OPTIMIZATION PROCESS

NSCAL SCALING CONTROL PARAMETER
- = -1 IF USER SUPPLIES SCALING VECTORS.
- = 0 IF THERE IS NO SCALING.
- = +1 FOR AUTOMATIC LINEAR SCALING EVERY NSCAL ITERATION.

GROUP 4:

NFDG GRADIENT CALCULATION CONTROL PARAMETER
- = 0 IF ALL GRADIENT INFORMATION WILL BE CALCULATED BY FINITE DIFFERENCE.
- = 1 IF ALL GRADIENT INFORMATION IS PROVIDED BY SUBROUTINE ANALYSIS.
- = 2 IF GRADIENT OF OBJECTIVE FUNCTION IS PROVIDED BY ANALYSIS.
  USE 0 IN THIS VERSION.

GROUP 5:

FDCH = 0.01 TO 0.025 TYPICALLY FOR TRANSONIC AIRFOIL DESIGN. RELATIVE CHANGE IN DECISION VARIABLE IN CALCULATING FINITE DIFFERENCE GRADIENTS.

FDCHM = 0.00075 TO 0.0005 TYPICALLY FOR TRANSONIC AIRFOIL DESIGN. MINIMUM ABSOLUTE STEP IN FINITE DIFFERENCE GRADIENT CALCULATIONS. USE A SMALLER VALUE WHEN THE AIRFOIL IS CLOSE TO THE OPTIMAL SHAPE.

GROUP 6:

ALPHAX = .1 TYPICALLY
ABOGJ1 = .1 TYPICALLY

GROUP 7:

NCON = NUMBER OF CONSTRAINT FUNCTIONS.
NSIDE = SIDE CONSTRAINT PARAMETER
= 0 IF DESIGN VARIABLES DO NOT HAVE LOWER OR UPPER BOUNDS. THIS IS THE OPTION IN THIS VERSION.
= 1 OTHERWISE.

GROUP 8:

LINOBJ = LINEAR OBJECTIVE FUNCTION IDENTIFIER.
= 0 FOR NONLINEAR OBJECTIVE FUNCTION.
= 1 FOR LINEAR OBJECTIVE FUNCTION.

GROUP 9:

CT = -.1 TYPICALLY. CONSTRAINT THICKNESS PARAMETER.
CTMIN = .004 TYPICALLY. MINIMUM ABSOLUTE VALUE OF CT CONSIDERED IN THE OPTIMIZATION PROCESS.
CTL = -.01 TYPICALLY. CONSTRAINT THICKNESS PARAMETER FOR LINEAR AND SIDE CONSTRAINTS.
CTLMIN = .001 TYPICALLY. MINIMUM ABSOLUTE VALUE OF CTL CONSIDERED IN THE OPTIMIZATION PROCESS.
THETA = 1. TYPICALLY. MEAN VALUE OF THE PUSH-OFF FACTOR IN THE METHOD OF FEASIBLE DIRECTIONS.
PHI = 5. TYPICALLY. PARTICIPATION COEFFICIENT, USED IF A DESIGN IS INFEASIBLE.

GROUP 10:

ITRM = 3 TYPICALLY. NUMBER OF CONSECUTIVE ITERATIONS TO INDICATE CONVERGENCE BY RELATIVE OR ABSOLUTE CHANGES, DELFUN OR DABFUN.

GROUP 11:

DELFUN = .001 TYPICALLY. MINIMUM RELATIVE CHANGE IN THE OBJECTIVE FUNCTION TO INDICATE CONVERGENCE.
DABFUN = .001 TYPICALLY. MINIMUM ABSOLUTE CHANGE IN THE OBJECTIVE FUNCTION TO INDICATE CONVERGENCE.

GROUP 12:

N1 = NDV + 2, WHERE NDV = NCOEF*2
NCOEF NUMBER OF TERMS IN THE FOURIER SERIES TO REPRESENT THE AIRFOIL UPPER AND LOWER SURFACES. $\geq$7 TYPICALLY.
IREP = 1 FOR READING DESIGN VARIABLES FROM PREVIOUS RUN FILE. RECOMMENDED IN SUBSEQUENT ADDITIONAL RUNS.
= 0 OTHERWISE.

IF NSCAL $\neq$ -1, SKIP GROUP 13.

GROUP 13:

SCAL(N5) VECTOR OF SCALING PARAMETERS, 40 VALUES. TYPICALLY, 40*0.001 FOR AIRFOIL DESIGN.

GROUP 14:

UPLIFT UPPER LIFT CONSTRAINT
DNLIFT LOWER LIFT CONSTRAINT
THTE TRAILING-EDGE THICKNESS

GROUP 15:

X1 THE X-COORDINATE BEYOND WHICH THE AIRFOIL SHAPE IS TO BE OPTIMIZED. NOTE THAT X(LE) = -0.5 AND X(TE) = 0.5.

*** THE FOLLOWING ARE MOSTLY TRANDES PARAMETERS. SEE NASA CR-2821 BY L. A. CARLSON. ***

GROUP 16: FREE STREAM CONDITIONS

M MACH NUMBER
ALP ANGLE OF ATTACK IN DEGREES
CIR NONDIMENSIONAL CIRCULATION (HALF LIFT COEFFICIENT); USUALLY STARTS WITH 0.0
CDCORR WAVE DRAG CORRECTION AT ZERO ANGLE OF ATTACK. CORRECTION SHOULD BE DETERMINED FOR EACH AIRFOIL AND GRID COMBINATION.
RN REYNOLDS NUMBER

GROUP 17: COORDINATE STRETCHING PARAMETERS.
DO NOT CHANGE THE SUGGESTED VALUES OF THIS GROUP.

A1 STRETCHING CONSTANT FOR THE Y DIRECTION. SUGGESTED VALUE 0.246.

A2 X DIRECTION STRETCHING CONSTANT IN THE AIRFOIL REGION. SUGGESTED VALUE = 0.15.

A3 X DIRECTION STRETCHING CONSTANT OUTSIDE THE AIRFOIL REGION. SUGGESTED VALUE = 3.87.

A4 THE POSITIVE X LOCATION WHERE THE COORDINATE STRETCHING CHANGES. SUGGESTED VALUE = 0.49.

S4 CORRESPONDING X4 VALUE IN THE TRANSFORMED PLANE. SUGGESTED VALUE = 2.0.

GROUP 18: OPTION SPECIFIERS

IUNIFM FLOW TYPE INDICATOR
= 0 FOR NONUNIFORM FLOW
1 FOR UNIFORM FLOW

INV PROGRAM MODE PARAMETER
= 0 FOR ANALYSIS OR DIRECT OPTIMIZATION
1 FOR DESIGN

ITACT VISCOUS INTERACTION INDICATOR
= 0 FOR INVISCID ANALYSIS AND DESIGN
1 FOR ANALYSIS WITH INTERACTION

ITERP INTERPOLATION INDICATOR IN INVERSE DESIGN FOR INTERPOLATING INPUT CP DISTRIBUTION IN GRID 4
= 0 CP TO BE READ IN GRID 4
= 1 CP INTERPOLATED FROM GRID-3 INPUT

IDEBUG DEBUG INDICATOR
= 0 NO DEBUGGING
1 DEBUGGING
2 CHECK PRESSURE DISTRIBUTION AT THE STABLE REGION FOR DESIGN

IREAD INDICATOR TO USE RESTART DATA
= 0 IF RESTART DATA ARE NOT USED
1 IF RESTART DATA ARE USED AND CONVERGED SOLUTION WILL BE COPIED BACK TO DISK.
= 2 IF RESTART DATA ARE READ FROM, BUT NOT WRITTEN ON, DISK 32. IN DIRECT OPTIMIZATION, DISK COPYING WILL BE DONE AT THE END OF EXECUTION.

ITIME PROGRAM RESTART INDICATOR
= 0 FOR NORMAL RUN
1 FOR 10-MINUTE CPU LIMIT BUILT IN THE PROGRAM

IHALF OPTION TO DETERMINE STARTING PHI VALUES FOR THE FINE GRIDS FROM VALUES CALCULATED IN THE COARSE GRIDS.
= 0 AVERAGE VALUE
1 ASYMMETRICAL QUADRATIC INTERPOLATION
2 ASYMMETRICAL CUBIC INTERPOLATION
3 SYMMETRICAL CUBIC INTERPOLATION

NOTE: IF IUNIFM = 1, SET ITERP = 0. TYPICALLY, IHALF = 0.

GROUP 19: NUMBER OF SPECIFIERS

IMAX NUMBER OF VERTICAL GRID LINES IN THE HORIZONTAL DIRECTION. LIMIT TO 97.
JMAX NUMBER OF HORIZONTAL GRID LINES IN THE VERTICAL DIRECTION. LIMIT TO 97.
NHALF NUMBER OF GRID REFINEMENTS. TYPICALLY, 2
MITER MAXIMUM NUMBER OF ITERATIONS. TYPICALLY, 1600-3200
LP RELAXATION CYCLE INTERVAL IN WHICH DETAILS OF BOUNDARY LAYER SURFACE COORDINATES, ETC., ARE PRINTED OUT. TYPICALLY, 4000-6000.

GROUP 20: VISCOUS INTERACTION PARAMETERS
INPUT TYPICAL VALUES FOR NO VISCOUS INTERACTION CASES

ITEUPC UPPER SURFACE TRAILING EDGE CORRECTION INDICATOR. ONLY USED IN THE VISCOUS INTERACTION CASE.
= 0 FOR NO CORRECTION (TYPICAL)
1 WITH CORRECTION
ITELWC LOWER SURFACE TRAILING EDGE CORRECTION INDICATOR. SAME AS ITEUPC.
SP MAXIMUM VALUE ALLOWED FOR THE NASH-MACDONALD SEPARATION PARAMETER WHEN X < XSEP. TYPICALLY, 0.004.
XSEP X LOCATION AFTER WHICH NASH-MACDONALD SEPARATION PARAMETER CAN ASSUME ITS CALCULATED VALUE. TYPICALLY, 0.44.
XLSEP LOCATION AT WHICH THE TRAILING EDGE CORRECTION PROCEDURE BEGINS. IT SHOULD CORRESPOND TO THE POINT OF SEPARATION. TYPICALLY, 0.50. USED ONLY IF ITEUPC AND/OR ITELWC = 1.
XPC LOCATION AFTER WHICH LOWER SURFACE DISPLACEMENT THICKNESS IS REQUIRED TO CONTINUE DECREASING ONCE IT HAS STARTED TO DECREASE.
= 0.1 FOR AFT-CAMBERED AIRFOILS
0.5 FOR CONVENTIONAL AIRFOILS
XIBDLY THE X-LOCATION AT WHICH TRANSITION IS ASSUMED TO OCCUR. TYPICALLY, -.44.

GROUP 21: NONUNIFORM FLOW PARAMETERS

ISWIRL = 0 NO SWIRL
1 SWIRL EXISTS DUE TO PROPELLER
IANALY = 0 UNIFORM FLOW
1 MACH NUMBER PROFILE BY EXPONENTIAL EXPRESSIONS
2 MACH NUMBER PROFILE FROM INPUT FOR NONUNIFORM FLOW.
ISTAG = 0 UNIFORM STAGNATION TEMPERATURE PROFILE
1 UNIFORM AMBIENT TEMPERATURE PROFILE (TYPICAL)
2 INPUT STAGNATION TEMPERATURE PROFILE
3 EXPONENTIAL STAGNATION TEMPERATURE PROFILE

```
IBU    = 0 LIFT COEFFICIENT BASED ON FREE-STREAM DYNAMIC
           PRESSURE
         1 LIFT COEFFICIENT BASED ON MAXIMUM FAR FIELD DYNAMIC
           PRESSURE
         2 LIFT COEFFICIENT BASED ON FAR FIELD DYNAMIC PRESSURE
           CORRESPONDING TO AIRFOIL STREAMLINE
```

GROUP 22: CONVERGENCE FACTORS

```
ICONV   CONVERGENCE OPTION INDICATOR.  A TYPICAL CHOICE IS 3.
        = 0 CONSTANT CONV FOR EACH GRID
          1 TWICE THE INPUT CONV FOR GRID ONE
          2 FIVE TIMES THE INPUT CONV FOR GRID ONE
          3 FIVE TIMES THE INPUT CONV FOR GRID ONE AND
            TWICE THE INPUT CONV FOR GRID TWO
          4 SAME AS 3, BUT FIX AND RESET RELAXATION FACTOR AND
            SUPERSONIC DAMPING FACTOR AFTER 800 AND 1600
            ITERATIONS.
          5 SAME AS 4, BUT INCREASE ICYL TO 15 AFTER 2400
            ITERATIONS
CONV    CONVERGENCE CRITERION.  IN DIRECT OPTIMIZATION, CONV IS
        INCREASED INTERNALLY BY 2.5 TIMES TO REDUCE CPU
        TIME IF CONV < 2.0 X 10^-6
        = 1.0E-6 (TYPICAL) FOR NONUNIFORM FLOW
          1.0E-4 (TYPICAL) FOR UNIFORM FLOW
RC      REFERENCE CONVERGENCE FACTOR.
        = 1000. TO 5000. TYPICAL FOR ANALYSIS
          200. TYPICAL FOR DESIGN
FD      RELATIVE CONVERGENCE FACTOR FOR NEWF.
        = 10. TO 50. TYPICALLY.  USE 1.0 FOR UNIFORM FLOW.
SD      RELATIVE CONVERGENCE FACTOR FOR SHAPE
        = 0.5 TYPICALLY.  USE 1.0 FOR UNIFORM FLOW.
VD      RELATIVE CONVERGENCE FACTOR FOR VISACT
        = 2. TO 5. TYPICALLY
```

GROUP 23: RELAXATION FACTORS
INPUT DEFAULT VALUES FOR THOSE WHICH ARE NOT NEEDED

```
W        RELAXATION FACTOR FOR PHI.
         1.4 TO 1.7 TYPICAL
UW       RELAXATION FACTOR FOR SHAPE.
         0.4 < UW < 1.0
RDEL     RELAXATION FACTOR FOR BOUNDARY LAYER DISPLACEMENT
         THICKNESS.  USED ONLY FOR VISCOUS INTERACTION FOR
         IMAX LE. 55.  TYPICALLY, 0.20.  IT IS REDUCED
         AUTOMATICALLY BY HALF IN THE LAST FINE GRIDS.  IT IS
         FURTHER REDUCED BY HALF IN DIRECT OPTIMIZATION.
RDELFN   RELAXATION FACTOR FOR BOUNDARY LAYER DISPLACEMENT
         FOR IMAX.  GT. 55.  TYPICALLY, 0.125.
```

GROUP 24: DAMPING FACTORS

EPS	SUBSONIC DAMPING FACTOR. TYPICALLY, 0.0.
EPSS	STARTING SUPERSONIC DAMPING FACTOR.
EPSMIN	MINIMUM SUPERSONIC DAMPING FACTOR. ROUGHLY EQUAL TO SQRT (MAXIMUM LOCAL MACH NUMBER**2 -1.)

GROUP 25: AIRFOIL CALCULATION REGION
THIS GROUP SHOULD BE INPUT ONLY ONCE IN ANALYSIS MODE.
THIS GROUP SHOULD BE INPUT FOR EACH GRID IN DESIGN.

X1 X LOCATION WHERE DIRECT CALCULATION STOPS.
= 0.5 IN ANALYSIS MODE OR IN DIRECT OPTIMIZATION.
IN DESIGN MODE ALLOW AT LEAST TWO GRID POINTS AHEAD OF IT. -0.38 TYPICALLY.

X2 END OF INVERSE REGION.
= 0.5 IN DESIGN MODE
10000. IN ANALYSIS MODE OR DIRECT OPTIMIZATION.

IF IANALY ≠, SKIP GROUP 26. IN A UNIFORM FLOW, SKIP GROUPS 26-32.

GROUP 26: EXPONENTIAL VELOCITY PROFILE PARAMETERS.
QINF = QI * (1. + AC * EXP (1-((Y - YS) / DD)**2))

AC DIFFERENCE BETWEEN PEAK NONUNIFORM MACH NUMBER AND FREE-STREAM MACH NUMBER.

YS VERTICAL LOCATION OF THE AIRFOIL RELATIVE TO THE NONUNIFORM STREAM CENTER.

DD : VERTICAL SPREAD OF THE MACH NUMBER NONUNIFORMITY

IF IANALY ≠ 2, SKIP GROUPS 27 AND 28.

GROUP 27: NUMERICAL MACH NUMBER PROFILE PARAMETERS

ISTA1 NUMBER OF STATIONS FOR SPECIFYING MACH NUMBER PROFILE

AC DIFFERENCE BETWEEN PEAK NONUNIFORM MACH NUMBER AND FREE STREAM MACH NUMBER.

GROUP 28: NUMERICAL MACH NUMBER PROFILE.

YLOC Y LOCATIONS WHERE VELOCITIES ARE TO BE INPUT, ISTA1 VALUES. NONDIMENSIONALIZED WITH AIRFOIL CHORD LENGTH. INPUT IN THE ORDER OF DECREASING VALUES.

VINF : CORRESPONDING MACH NUMBERS, ISTA1 VALUES.

IF ISTAG ≠ 2, SKIP GROUPS 29 AND 30.

GROUP 29:

ISTA2 NUMBER OF STATIONS TO SPECIFY STAGNATION TEMPERATURE PROFILE.

GROUP 30: STAGNATION TEMPERATURE PROFILE.

YLOC Y LOCATIONS WHERE STAGNATION TEMPERATURES ARE TO BE INPUT, ISTA2 VALUES. NONDIMENSIONALIZED WITH AIRFOIL CHORD LENGTH. INPUT IN THE ORDER OF DECREASING VALUES.

TMP : CORRESPONDING STAGNATION TEMPERATURE VALUES, ISTA2 VALUES.

IF ISTAG $\neq$ 3, SKIP GROUP 31.

GROUP 31: EXPONENTIAL TEMPERATURE PROFILE PARAMETERS
TEM = (1 + TC * EXP(-((Y - TS)/TD)**2))

TC DIFFERENCE BETWEEN PEAK TEMPERATURE AND FREE STREAM TEMPERATURE

TS VERTICAL LOCATION OF THE AIRFOIL RELATIVE TO THE NONUNIFORM TEMPERATURE PROFILE CENTER

TD VERTICAL SPREAD OF THE TEMPERATURE NONUNIFORMITY

IF ISWIRL $\neq$ 1, SKIP GROUP 32.

GROUP 32: SWIRL PARAMETERS

SWANG SWIRL ANGLE IN DEGREES

SWBL Y COORDINATE BELOW WHICH FREE STREAM CONDITIONS PREVAIL

SWBU Y COORDINATE ABOVE WHICH FREE STREAM CONDITIONS PREVAIL

GROUP 33:

NI NUMBER OF COORDINATE PAIRS TO DESCRIBE THE UPPER SURFACE OF THE AIRFOIL. LIMITED TO 110.

GROUP 34:

(XI, YI) AIRFOIL UPPER SURFACE COORDINATES (X, Y) NONDIMENSIONALIZED WITH CHORD LENGTH. NI PAIRS. INPUT FROM THE LEADING EDGE TO THE TRAILING EDGE. X(LE) = 0. AND X(TE) = 1.0.

GROUP 35: UPPER SURFACE SLOPES

DERIX	DX/DS OF THE AIRFOIL UPPER SURFACE AT THE LEADING EDGE. TYPICALLY, 0.0.
DERIY	DY/DS OF THE AIRFOIL UPPER SURFACE AT THE TRAILING EDGE. TYPICALLY, 1.0.
DERFX	THIRD DERIVATIVE OF DX/DS OF THE AIRFOIL UPPER SURFACE AT THE TRAILING EDGE. TYPICALLY, 0.0.
DERFY	THIRD DERIVATIVE OF DY/DS OF THE AIRFOIL UPPER SURFACE AT THE TRAILING EDGE. TYPICALLY, 0.0.

GROUP 36:

NIB	NUMBER OF COORDINATE PAIRS TO DESCRIBE THE AIRFOIL LOWER SURFACE. LIMITED TO 110.

GROUP 37:

(XIB,YIB)	AIRFOIL LOWER SURFACE COORDINATES (x, y). NONDIMENSIONAL IZED WITH CHORD LENGTH. NIB PAIRS. INPUT FROM THE LEADING EDGE TO THE TRAILING EDGE. X(LE) = 0. AND X(TE) = 1.0.

GROUP 38: LOWER SURFACE SLOPES.

DERIXB	DX/DS OF THE AIRFOIL LOWER SURFACE AT THE LEADING EDGE. TYPICALLY, 0.0.
DERIYB	DY/DS OF THE AIRFOIL LOWER SURFACE AT THE LEADING EDGE. TYPICALLY, -1.0.
DERFXB	THIRD DERIVATIVE OF DX/DS OF THE AIRFOIL LOWER SURFACE AT THE TRAILING EDGE. TYPICALLY, 0.0.
DERFYB	THIRD DERIVATIVE OF DY/DS OF THE AIRFOIL LOWER SURFACE AT THE TRAILING EDGE. TYPICALLY, 0.0.

SKIP GROUPS 39-40 IF

1. ANALYSIS CASES OR DIRECT OPTIMIZATION
2. MHALF = 1
3. ITERP = 1 AND GRID FINER THAN GRID 3

THIS GROUP SHOULD BE INPUT FOR GRID 2 AND 3.
IF ITERP = 0, IT SHOULD ALSO BE INPUT FOR GRID 4.

GROUP 39:

CPU	SPECIFIED C_p DISTRIBUTION ON THE UPPER SURFACE AT GRID POINTS. INPUT FROM THE LEADING EDGE TO THE TRAILING EDGE. SEE NASA CR-2821.

GROUP 40:

CPL SPECIFIED C_p DISTRIBUTION ON THE LOWER SURFACE AT GRIP POINTS. INPUT FROM THE LEADING EDGE TO THE TRAILING EDGE. SEE NASA CR-2821.

OUTPUT VARIABLES

The following output is available on file #30 for each grid.

(1) The input profiles for the free-stream Mach number and temperature are first printed.

(2) Heading

(3) Listing of input data

(4) Cartesian grid coordinates. Pairs of I,X(I) are first printed. These are followed with pairs of J,Y(J).

(5) Airfoil coordinates

X	HORIZONTAL COORDINATE WITH -0.5 BEING THE LEADING EDGE AND 0.5 BEING THE TRAILING EDGE
YU	UPPER SURFACE ORDINATE
YL	LOWER SURFACE ORDINATE
UPPER SLOPE	UPPER SURFACE SLOPE
LOWER SLOPE	LOWER SURFACE SLOPE

(6) Iteration history

ITER	ITERATION NUMBER
CIR	CIRCULATION
DPM	MAXIMUM Φ CORRECTION AT THE GRID LOCATION (I,J)
NSSP	NUMBER OF SUPERSONIC POINTS
DELTA	MAXIMUM BOUNDARY LAYER DISPLACEMENT THICKNESS
EPSS	SUPERSONIC DAMPING FACTOR
W	RELAXATION FACTOR FOR Φ
UW	RELAXATION FACTOR FOR AIRFOIL SHAPE IN INVERSE DESIGN

(7) Results of boundary layer analysis (for cases with viscous interaction only)

X	HORIZONTAL COORDINATE
YUORIG	ORIGINAL UPPER SURFACE ORDINATE
DU	UPPER SURFACE DISPLACEMENT THICKNESS
SLU	SLOPE OF UPPER SURFACE ORDINATE
YLORIG	ORIGINAL LOWER SURFACE ORDINATE
DL	LOWER SURFACE DISPLACEMENT THICKNESS
SLL	SLOPE OF LOWER SURFACE

(8) Pressure distribution on airfoil

X	HORIZONTAL COORDINATE
CPU	PRESSURE COEFFICIENT C_p ON THE UPPER SURFACE
CPL	PRESSURE COEFFICIENT ON THE LOWER SURFACE

(9) Airfoil shape with boundary layer displacement thickness included

X	HORIZONTAL COORDINATE
YU	UPPER SURFACE ORDINATE
YL	LOWER SURFACE ORDINATE
SLU	SLOPE OF UPPER SURFACE
SLL	SLOPE OF LOWER SURFACE

(10) Mach number chart

"I" increases from top to bottom and "J" increases from left to right. The actual value of Mach number is the printed value divided by 100.

(11) Wave drag coefficient and wave drag correction (CDCORR)

(12) Plot of results

U	UPPER SURFACE C_c
L	LOWER SURFACE C_p
T	UPPER DISPLACEMENT SURFACE
B	LOWER DISPLACEMENT SURFACE
CPSTAR	CRITICAL PRESSURE COEFFICIENT, C_p*
CLCIR	LIFT COEFFICIENT FROM CIRCULATION
CL	LIFT COEFFICIENT FROM C_p INTEGRATION
CD	TOTAL DRAG COEFFICIENT
CMLE	PITCHING MOMENT COEFFICIENT ABOUT THE LEADING EDGE
CDF	SKIN FRICTION DRAG COEFFICIENT
CMC4	PITCHING MOMENT COEFFICIENT ABOUT THE QUARTER-CHORD POINT

(13) CPU time

In direct optimization, various CONMIN variables may be printed, depending on printing options. For details, Reference 3 should be consulted.

PROGRAM EXECUTION

This code is written in Fortran 77 language. It is operational on the Harris-1000 computer at the University of Kansas and the CDC Cyber 175 computer system at the NASA Langley Research center.

The following files used during execution are defined in the program:

FILE VARIABLE	FILE NUMBER	USAGE
INPUT	20	INPUT DATA
	22	TO STORE DESIGN VARIABLES FOR RESTART IN DIRECT OPTIMIZATION
JOUT	30	OUTPUT
IOUT	31	DATA IN INPUT-DATA FORMAT CONTAINING THE FINAL AIRFOIL COORDINATES IN DIRECT OPTIMIZATION FOR RESTART
LOUT	32	CONTAIN SOLUTION IN BINARY FORMAT FOR RESTART
KOUT	33	OUTPUT FOR DEBUGGING

File numbers may be redefined in BLOCK DATA. The file #22 is used in Subroutines OPT and COEFI.

Execution in analysis and inverse design is straightforward. In direct optimization, the following steps are recommended.

(1) With an assumed starting airfoil, run the code in analysis mode with IREAD = 0 (see GROUP 18). The converged solution is automatically saved on file LOUT (#32).

(2) Change the input file for direct optimization. The following values for some input variables are recommended:

ITMAX = 2 (GROUP 3)

IREP = 0 (GROUP 12)

IREAD = 1 (GROUP 18)

CONV = 2.5×10^{-6} (GROUP 12)

RDEL = 0.1 (GROUP 23)

EPSS = 3.0 (GROUP 24)

(3) The final solution is again saved on file LOUT (#32). If the output indicates that the objective function is not changed, FDCHM (GROUP 5) may be slightly increased. To restart, copy file IOUT (#31) to file INPUT (#20), and IREP (GROUP 12) is set to 1. ITMAX (GROUP 3) may be increased. Other variables in step (2) remain the same.

(4) For any subsequent restart, step (3) is repeated.

(5) After a satisfactory airfoil shape is obtained, file IOUT (#31) is copied to file INPUT (#20) again. The file INPUT (#20) is then changed for analysis only. For this final analysis, the following values for some input variables are recommended:

IREAD = 1 (GROUP 18)

CONV = 1.0×10^{-6} (GROUP 23)

RDEL = 0.2 (GROUP 23)

EPSS = 2.5 (GROUP 24)

SAMPLE INPUT AND OUTPUT

1. Input Data for Sample Case 1

```
1AIRFOIL ANALYSIS IN NON-UNIFORM TRANSONIC FLOW
  .8          0.          0.          0.          20950000.
  .246        .15         3.87        .49         2.
  0     0     1     0     0     0     0   0
 13    13     2  3200  6000
  0     0     .004        .44         .5          .1          -.44
  1     2     1     0
  3           .000001     2000.       50.         1.          5.
 1.4          1.          .1          .125
 0.           5.          1.4
     .5   10000.
         26   .133
  .52         .45         .4          .35         .3          .25         .2          .15
  .1          .05         0.          -.05        -.1         -.15        -.2         -.25
 -.3          -.35        -.4         -.45        -.5         -.55        -.6         -.65
 -.7          -.75
  .8          .85         .851        .853        .903        .908        .91         .91
  .911        .916        .923        .928        .933        .933        .928        .923
  .923        .911        .91         .91         .908        .903        .853        .851
  .85         .8
 4.86         -.57683     .32533
103
0.            0.          .002        .00925      .005        .01429      .01         .01962
  .02         .02653      .03         .03127      .04         .03471      .05         .03759
  .06         .03991      .07         .04196      .08         .04374      .09         .04537
  .1          .04683      .11         .04814      .12         .04938      .13         .05054
  .14         .05161      .15         .05261      .16         .05352      .17         .05439
  .18         .05521      .19         .05596      .20         .05664      .21         .05726
  .22         .05784      .23         .05839      .24         .05888      .25         .05932
  .26         .05973      .27         .0601       .28         .06043      .29         .06072
  .30         .06098      .31         .0612       .32         .06139      .33         .06152
  .34         .0616       .35         .06166      .36         .06173      .37         .06173
  .38         .06173      .39         .06170      .40         .06163      .41         .0615
  .42         .06136      .43         .06118      .44         .06098      .45         .06074
  .46         .06048      .47         .06019      .48         .05988      .49         .05954
  .50         .05917      .51         .05876      .52         .05834      .53         .0579
  .54         .05741      .55         .05688      .56         .05632      .57         .05573
  .58         .05511      .59         .05447      .60         .05378      .61         .05308
  .62         .05233      .63         .05157      .64         .05077      .65         .04994
  .66         .04906      .67         .04818      .68         .04727      .69         .04631
  .7          .0453       .71         .04426      .72         .04319      .73         .04207
  .74         .04091      .75         .03973      .76         .03850      .77         .03722
  .78         .03589      .79         .03452      .8          .03312      .81         .03168
  .82         .03018      .83         .02866      .84         .02711      .85         .02553
  .86         .02387      .87         .02215      .88         .02040      .89         .01864
  .9          .01682      .91         .01494      .92         .013        .93         .01103
  .94         .009        .95         .00691      .96         .00476      .97         .00256
  .98         .00029      .99         -.00204     1.          -.00444
0.0           1.0         0.0         0.0
103
0.            0.          .002        -.00713     .005        -.01227     .01         -.01774
  .02         -.02471     .03         -.02928     .04         -.03297     .05         -.03601
  .06         -.03867     .07         -.04101     .08         -.04312     .09         -.04501
  .10         -.04675     .11         -.04832     .12         -.04981     .13         -.0512
  .14         -.05247     .15         -.05369     .16         -.05479     .17         -.05582
  .18         -.05678     .19         -.05767     .20         -.05854     .21         -.05929
  .22         -.05998     .23         -.06062     .24         -.06121     .25         -.06174
  .26         -.06222     .27         -.06264     .28         -.063       .29         -.06334
  .30         -.0636      .31         -.06384     .32         -.06401     .33         -.06417
```

.34	-.06428	.35	-.06435	.36	-.06439	.37	-.06437
.38	-.06432	.39	-.06423	.40	-.06408	.41	-.06391
.42	-.06363	.43	-.06332	.44	-.06297	.45	-.06252
.46	-.06204	.47	-.0615	.48	-.06090	.49	-.06027
.50	-.05957	.51	-.05879	.52	-.05796	.53	-.05706
.54	-.05608	.55	-.05506	.56	-.05389	.57	-.05269
.58	-.05141	.59	-.05005	.6	-.04859	.61	-.04709
.62	-.0455	.63	-.04388	.64	-.04217	.65	-.04046
.66	-.0387	.67	-.03692	.68	-.03511	.69	-.0333
.7	-.03149	.71	-.02967	.72	-.02786	.73	-.02605
.74	-.02425	.75	-.02246	.76	-.02073	.77	-.01904
.78	-.01739	.79	-.01579	.8	-.01424	.81	-.01275
.82	-.01139	.83	-.01009	.84	-.00889	.85	-.0078
.86	-.00684	.87	-.00599	.88	-.00534	.89	-.00478
.9	-.00436	.91	-.00412	.92	-.00413	.93	-.00434
.94	-.00478	.95	-.00542	.96	-.00627	.97	-.00744
.98	-.00889	.99	-.01058	1.	-.01255		
0.0	-1.0	0.0	0.0				

2. Output for Sample Case 1

```
 FREESTREAM MACH NUMBER PROFILE
    0.8000    0.8000    0.9105    0.9231    0.9334    0.9297    0.9230    0.9140    0.9099    0.9078    0.8555    0.8000

 FREESTREAM STAGNATION TEMPERATURE PROFILE
    1.1280    1.1280    1.1559    1.1704    1.1742    1.1729    1.1704    1.1671    1.1656    1.1648    1.1464    1.1280

 MACH NUMBER DIVIDED BY SQRT(STAGNATION TEMPERATURE)
    0.7532    0.7532    0.8434    0.8532    0.8514    0.8585    0.8532    0.8461    0.8428    0.8411    0.7990    0.7532
1
 NASA AIRFOIL IN NON-UNIFORM FLOW ( NASA ORIGINAL )
0    MACH NO. IS 0.800 ANGLE OF ATTACK IS      0.000 DEGREES
              DIRECT SOLUTION TO      0.50
0    INVISCID ANALYSIS CASE
     WITH VISCOUS INTERACTION
  0.80000   0.00000   0.00000   0.00000 20950000.00000
  0.24600   0.15000   3.87000   0.49000   2.00000
   0    0     1    0     0    0     0    0
  13   13     2 3200 6000
   0    0   0.00430   0.44000   0.10000  -0.44000
   1    2     1    0
            3 0.0000050 2000.00000  50.00000   1.00000   5.00000
  1.40000   1.00000   0.10000   0.12500
  0.00000   5.00000   1.40000


                       X-Y GRID SYSTEM

    1 -0.3872E+01    2 -0.1410E+01    3 -0.4900E+00    4 -0.3706E+00    5 -0.2485E+00    6 -0.1247E+00    7  0.0000E+01
  8  0.1247E+00    9  0.2435E+00   10  0.3706E+00   11  0.4900E+00   12  0.1410E+01   13  0.3872E+01
    1 -0.1869E+01    2 -0.9181E+00    3 -0.4261E+00    4 -0.2460E+00    5 -0.1420E+00    6 -0.6592E-01    7 -0.4217E-11
  8  0.6592E-01    9  0.1420E+00   10  0.2460E+00   11  0.4261E+00   12  0.9181E+00   13  0.1869E+01
0                     AIRFOIL COORDINATES
      X         YU        YL     UPPER SLOPE LOWER SLOPE
  -0.49000   0.01962  -0.01774   0.88006  -0.89823
  -0.37058   0.05048  -0.05112   0.11180  -0.13300
  -0.24852   0.05938  -0.06181   0.04211  -0.04976
  -0.12470   0.06173  -0.06435   0.00038   0.00500
   0.00000   0.05917  -0.05957  -0.03920   0.07438
   0.12470   0.05198  -0.04475  -0.07558   0.16103
   0.24852   0.03991  -0.02272  -0.11928   0.17750
   0.37058   0.02205  -0.00595  -0.17427   0.07314
   0.49000  -0.00204  -0.01058  -0.23630  -0.18235
  BEGINNING EPSS=    5.00000  BEGINNING RDEL=    0.10000
 BEGIN NEWF
 AT ITERATION =     10
 ITER =    10 CIR =     0.12949 DPM =    0.0260611 AT  4   6 NSSP =    16 DELTA =   0.0000 EPSS = 5.00 W = 1.40 UW = 1.00
 ITER =    20 CIR =     0.20734 DPM =    0.0160073 AT  5   6 NSSP =    56 DELTA =   0.0000 EPSS = 5.00 W = 1.45 UW = 1.00
 ITER =    30 CIR =     0.25141 DPM =    0.0079359 AT  5   6 NSSP =    60 DELTA =   0.0000 EPSS = 4.90 W = 1.50 UW = 1.00
 ITER =    40 CIR =     0.29083 DPM =    0.0047989 AT  5   6 NSSP =    61 DELTA =   0.0000 EPSS = 4.80 W = 1.55 UW = 1.00
 ITER =    50 CIR =     0.31283 DPM =    0.0034463 AT 11   6 NSSP =    63 DELTA =   0.0000 EPSS = 4.70 W = 1.60 UW = 1.00
 ITER =    60 CIR =     0.32560 DPM =    0.0026416 AT 11   6 NSSP =    62 DELTA =   0.0000 EPSS = 4.60 W = 1.65 UW = 1.00
 ACCEPTABLE REGION FOR ANALYSIS
 AT ITERATION =     70
 ITER =    70 CIR =     0.33384 DPM =    0.0019384 AT 11   6 NSSP =    62 DELTA =   0.0000 EPSS = 4.50 W = 1.70 UW = 1.00
 STABLE REGION
 AT ITERATION =     80
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ITER =    80 CIR =      0.33999 DPM =    0.0013852 AT 11   6 NSSP =    62 DELTA =  0.0000 EPSS = 4.40 W = 1.70 UW = 1.00
ITER =    90 CIR =      0.34483 DPM =    0.0009773 AT 11   6 NSSP =    62 DELTA =  0.0000 EPSS = 4.30 W = 1.70 UW = 1.00
ITER =   100 CIR =      0.34649 DPM =    0.0006355 AT 11   6 NSSP =    62 DELTA =  0.0000 EPSS = 4.20 W = 1.70 UW = 1.00
ITER =   110 CIR =      0.35109 DPM =    0.0004779 AT 11   6 NSSP =    62 DELTA =  0.0000 EPSS = 4.10 W = 1.70 UW = 1.00
ITER =   120 CIR =      0.35292 DPM =    0.0003312 AT 11   6 NSSP =    62 DELTA =  0.0000 EPSS = 4.00 W = 1.70 UW = 1.00
ITER =   130 CIR =      0.35420 DPM =    0.0002282 AT 11   6 NSSP =    62 DELTA =  0.0000 EPSS = 3.90 W = 1.70 UW = 1.00
ITER =   140 CIR =      0.35509 DPM =    0.0001565 AT 11   6 NSSP =    62 DELTA =  0.0000 EPSS = 3.80 W = 1.70 UW = 1.00
ITER =   150 CIR =      0.35570 DPM =    0.0001069 AT 11   6 NSSP =    62 DELTA =  0.0000 EPSS = 3.70 W = 1.70 UW = 1.00
ITER =   160 CIR =      0.35612 DPM =    0.0000729 AT 11   6 NSSP =    62 DELTA =  0.0000 EPSS = 3.60 W = 1.70 UW = 1.00
ITER =   170 CIR =      0.35641 DPM =    0.0000496 AT 11   6 NSSP =    62 DELTA =  0.0000 EPSS = 3.50 W = 1.70 UW = 1.00
ITER =   180 CIR =      0.35660 DPM =    0.0000338 AT 11   6 NSSP =    62 DELTA =  0.0000 EPSS = 3.40 W = 1.70 UW = 1.00
ITER =   190 CIR =      0.35674 DPM =    0.0000230 AT 11   6 NSSP =    62 DELTA =  0.0000 EPSS = 3.30 W = 1.70 UW = 1.00
ITER =   200 CIR =      0.35683 DPM =    0.0000157 AT 11   6 NSSP =    62 DELTA =  0.0000 EPSS = 3.20 W = 1.70 UW = 1.00
ITER =   210 CIR =      0.35689 DPM =    0.0000107 AT 11   6 NSSP =    62 DELTA =  0.0000 EPSS = 3.10 W = 1.70 UW = 1.00
ITER =   220 CIR =      0.35694 DPM =    0.0000073 AT 11   6 NSSP =    62 DELTA =  0.0000 EPSS = 3.00 W = 1.70 UW = 1.00
ITER =   230 CIR =      0.35697 DPM =    0.0000050 AT 11   6 NSSP =    62 DELTA =  0.0000 EPSS = 2.90 W = 1.70 UW = 1.00
ITER =   232 CIR =      0.35697 DPM =    0.0000047 AT 11   6 NSSP =    62 DELTA =  0.0000 EPSS = 2.80 W = 1.70 UW = 1.00
 CP BY CENTRAL DIFFERENCES
X              CPU           CPL
   -0.49000    0.32959      0.46716
   -0.37058   -0.97271     -0.87539
   -0.24852   -1.16982     -1.12785
   -0.12470   -1.28248     -1.28994
    0.00000   -1.36494     -1.42329
    0.12470   -1.43584     -1.62004
    0.24852   -1.53493     -0.11899
    0.37058   -1.99536      1.41096
    0.49000   -0.61673     -0.01298
    1.40979   -0.02128     -0.02123
     X              YU            YL           SLU          SLL
   -0.49000     0.01962     -0.01774      0.88006     -0.89823
   -0.37058     0.05043     -0.05112      0.11180     -0.13300
   -0.24852     0.05938     -0.06181      0.04211     -0.04976
   -0.12470     0.06173     -0.06435      0.00033      0.00500
    0.00000     0.05917     -0.05957     -0.03920      0.07438
    0.12470     0.05198     -0.04475     -0.07558      0.16103
    0.24852     0.03991     -0.02272     -0.11928      0.17750
    0.37058     0.02205     -0.00595     -0.17427      0.07314
    0.49000    -0.00204     -0.01058     -0.23630     -0.18235
1
  75 75 75 74 73 74 75 76 78 81 85
  69 67 69 69 73  0 78 74 73 75 84
  86 97110118131  0137122111103 99
  91109125136146  0149139128116105
  95119136148157  0156150140127110
  97127144155167  0162157149136114
  95142163175185  0168161155143116
  87108110107 96  0177167160148119
  82 70 56 45 28  0246228214193141
  83 90 92 92 92  0118120120119108
  78 86 89 90 91 92 93 94 95 97 96
0                           WAVE CD =    0.129697  CDCORR =  0.000000
1 NASA AIRFOIL IN NON-UNIFORM FLOW ( NASA ORIGINAL )

     -0.4900                                                    TB        U   L
```

```
 -0.3700                         U L                       T   B

 -0.2300                      UL                           T   B

 -0.1100                    L                              T   B

  0.0100                  L U                              T   B

  0.1300                L   U                              T B

  0.2500                  U                               L T B

  0.3900      U                                            TB                     L

  0.4900                                    U              B
0            -1.995   -1.655   -1.314   -0.973   -0.633   -0.292   0.048   0.389   0.730   1.070   1.411
                                            PRESSURE COEFFICIENT

                                        CPSTAR =       -0.1965      CLCIR =      0.7139
0                         CL =      0.6191 CD =   0.129697 CMLE =    -0.5117 CDF =   0.000000 CMC4 =    -0.3569
 FINAL EPSS =    2.800000
1
  FREESTREAM MACH NUMBER PROFILE
     0.8000     0.8000     0.8000     0.8579     0.9106     0.9185     0.9231     0.9294     0.9334     0.9331     0.9297     0.9263     0.9230
     0.9185     0.9140     0.9109     0.9099     0.9104     0.9078     0.8831     0.8555     0.8000     0.8000     0.8000     0.8000

  FREESTREAM STAGNATION TEMPERATURE PROFILE
     1.1280     1.1280     1.1280     1.1472     1.1659     1.1687     1.1704     1.1728     1.1742     1.1741     1.1729     1.1716     1.1704
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    1.1687    1.1671    1.1659    1.1656    1.1658    1.1648    1.1560    1.1464    1.1280    1.1280    1.1280    1.1280
 MACH NUMBER DIVIDED BY SQRT(STAGNATION TEMPERATURE)
    0.7532    0.7532    0.7532    0.8010    0.8434    0.8496    0.8532    0.8582    0.8614    0.8611    0.8585    0.8553    0.8532
    0.8496    0.8461    0.8436    0.8428    0.8432    0.8411    0.8214    0.7990    0.7532    0.7532    0.7532    0.7532
1
 NASA AIRFOIL IN NON-UNIFORM FLOW ( NASA ORIGINAL )
0   MACH NO. IS 0.800 ANGLE OF ATTACK IS     0.000 DEGREES
            DIRECT SOLUTION TO       0.50
0   INVISCID ANALYSIS CASE
    WITH VISCOUS INTERACTION
  0.80000   0.00000   0.35697   0.00000 20950000.00000
  0.24600   0.15000   3.87000   0.49000   2.00000
   0    0     1    0     0    0    0    0
  25   25     2 3200  6000
   0    0   0.00400   0.44000   0.10000  -0.44000
   1    2     1    0
        3 0.0000020 2000.00000  50.00000   1.00000   5.00000
  1.40000   1.00000   0.10000   0.12500
  0.00000   5.00000   1.40000

                      X-Y GRID SYSTEM

   1 -0.8027E+01    2 -0.3872E+01    3 -0.1410E+01    4 -0.6471E+00    5 -0.4900E+00    6 -0.4307E+00    7 -0.3706E+00
   8 -0.3098E+00    9 -0.2485E+00   10 -0.1868E+00   11 -0.1247E+00   12 -0.6240E-01   13  0.0000E+01   14  0.6240E-01
  15  0.1247E+00   16  0.1868E+00   17  0.2485E+00   18  0.3098E+00   19  0.3706E+00   20  0.4307E+00   21  0.4900E+00
  22  0.6471E+00   23  0.1410E+01   24  0.3872E+01   25  0.8027E+01
   1 -0.3753E+01    2 -0.1869E+01    3 -0.9181E+00    4 -0.5939E+00    5 -0.4261E+00    6 -0.3206E+00    7 -0.2460E+00
   8 -0.1838E+00    9 -0.1420E+00   10 -0.1019E+00   11 -0.6592E-01   12 -0.3239E-01   13 -0.6326E-11   14  0.3239E-01
  15  0.6592E-01   16  0.1019E+00   17  0.1420E+00   18  0.1838E+00   19  0.2460E+00   20  0.3206E+00   21  0.4261E+00
  22  0.5939E+00   23  0.9181E+00   24  0.1869E+01   25  0.3753E+01
0                    AIRFOIL COORDINATES
      X          YU        YL      UPPER SLOPE  LOWER SLOPE
  -0.49000   0.01962  -0.01774   0.83006  -0.89823
  -0.43067   0.04183  -0.04036   0.19335  -0.22300
  -0.37058   0.05048  -0.05112   0.11180  -0.13330
  -0.30982   0.05597  -0.05769   0.07127  -0.08878
  -0.24852   0.05938  -0.06181   0.04211  -0.04976
  -0.18677   0.06127  -0.06390   0.01994  -0.01738
  -0.12470   0.06173  -0.06435   0.00038   0.00500
  -0.06240   0.06103  -0.06306  -0.02070   0.03712
   0.00000   0.05917  -0.05957  -0.03920   0.07438
   0.06240   0.05618  -0.05360  -0.05813   0.11894
   0.12470   0.05198  -0.04475  -0.07558   0.16103
   0.18677   0.04663  -0.03388  -0.09694   0.18085
   0.24852   0.03991  -0.02272  -0.11928   0.17750
   0.30982   0.03171  -0.01278  -0.14714   0.14267
   0.37058   0.02205  -0.00595  -0.17427   0.07314
   0.43067   0.01090  -0.00436  -0.20010  -0.03395
   0.49000  -0.00204  -0.01058  -0.23630  -0.18235
  BEGINNING EPSS=   5.00000  BEGINNING RDEL=   0.10000
 BEGIN NEWF
 AT ITERATION =    10
 BEGIN VISACT
 AT ITERATION =    10
 ITER =   10 CIR =   0.30836 DPM =   0.0060616 AT  7 11 NSSP =  223 DELTA =  0.0000 EPSS = 5.00 W = 1.40 UW = 1.00
 ITER =   20 CIR =   0.30872 DPM =   0.0044023 AT  8 11 NSSP =  171 DELTA =  0.0006 EPSS = 5.00 W = 1.45 UW = 1.00
 ITER =   30 CIR =   0.31422 DPM =   0.0036329 AT  8 11 NSSP =  160 DELTA =  0.0013 EPSS = 4.90 W = 1.50 UW = 1.00
```

```
ITER =    40 CIR =     0.31890 DPM =     0.0026790 AT  8 11 NSSP =  151 DELTA =  0.0020 EPSS = 4.80 W = 1.55 UW = 1.00
ACCEPTABLE REGION FOR ANALYSIS
AT ITERATION =      50
ITER =    50 CIR =     0.32215 DPM =     0.0019909 AT  3 11 NSSP =  148 DELTA =  0.0026 EPSS = 4.70 W = 1.60 UW = 1.00
STABLE REGION
AT ITERATION =      60
ITER =    60 CIR =     0.32337 DPM =     0.0014819 AT  3 11 NSSP =  143 DELTA =  0.0033 EPSS = 4.60 W = 1.65 UW = 1.00
ITER =    70 CIR =     0.32300 DPM =     0.0012341 AT 10 15 NSSP =  139 DELTA =  0.0038 EPSS = 4.50 W = 1.70 UW = 1.00
ITER =    80 CIR =     0.32249 DPM =     0.0009961 AT 10 15 NSSP =  137 DELTA =  0.0044 EPSS = 4.40 W = 1.70 UW = 1.00
ITER =    90 CIR =     0.32210 DPM =     0.0007583 AT 11 15 NSSP =  138 DELTA =  0.0048 EPSS = 4.30 W = 1.70 UW = 1.00
ITER =   100 CIR =     0.32173 DPM =     0.0006002 AT 12 15 NSSP =  139 DELTA =  0.0053 EPSS = 4.20 W = 1.70 UW = 1.00
ITER =   110 CIR =     0.32146 DPM =     0.0004839 AT 13 15 NSSP =  140 DELTA =  0.0057 EPSS = 4.10 W = 1.70 UW = 1.00
ITER =   120 CIR =     0.32124 DPM =     0.0003914 AT 14 15 NSSP =  142 DELTA =  0.0061 EPSS = 4.00 W = 1.70 UW = 1.00
ITER =   130 CIR =     0.32110 DPM =     0.0003251 AT 15 15 NSSP =  141 DELTA =  0.0065 EPSS = 3.90 W = 1.70 UW = 1.00
ITER =   140 CIR =     0.32108 DPM =     0.0002756 AT 17 15 NSSP =  143 DELTA =  0.0069 EPSS = 3.80 W = 1.70 UW = 1.00
ITER =   150 CIR =     0.32121 DPM =     0.0002385 AT 18 15 NSSP =  144 DELTA =  0.0072 EPSS = 3.70 W = 1.70 UW = 1.00
ITER =   160 CIR =     0.32146 DPM =     0.0002096 AT 19 14 NSSP =  144 DELTA =  0.0075 EPSS = 3.60 W = 1.70 UW = 1.00
ITER =   170 CIR =     0.32157 DPM =     0.0001308 AT 20 14 NSSP =  143 DELTA =  0.0078 EPSS = 3.50 W = 1.70 UW = 1.00
ITER =   180 CIR =     0.32157 DPM =     0.0001523 AT 20 14 NSSP =  143 DELTA =  0.0080 EPSS = 3.40 W = 1.70 UW = 1.00
ITER =   190 CIR =     0.32150 DPM =     0.0001223 AT 20 14 NSSP =  143 DELTA =  0.0083 EPSS = 3.30 W = 1.70 UW = 1.00
ITER =   200 CIR =     0.32134 DPM =     0.0000934 AT 20 14 NSSP =  143 DELTA =  0.0085 EPSS = 3.20 W = 1.70 UW = 1.00
ITER =   210 CIR =     0.32112 DPM =     0.0000697 AT 20 14 NSSP =  143 DELTA =  0.0087 EPSS = 3.10 W = 1.70 UW = 1.00
ITER =   220 CIR =     0.32080 DPM =     0.0000523 AT 20 14 NSSP =  142 DELTA =  0.0089 EPSS = 3.00 W = 1.70 UW = 1.00
ITER =   230 CIR =     0.32040 DPM =     0.0000441 AT 22 12 NSSP =  142 DELTA =  0.0091 EPSS = 2.90 W = 1.70 UW = 1.00
ITER =   240 CIR =     0.31995 DPM =     0.0000443 AT 22 12 NSSP =  142 DELTA =  0.0092 EPSS = 2.80 W = 1.70 UW = 1.00
ITER =   250 CIR =     0.31950 DPM =     0.0000442 AT 22 12 NSSP =  142 DELTA =  0.0093 EPSS = 2.80 W = 1.70 UW = 1.00
ITER =   260 CIR =     0.31904 DPM =     0.0000439 AT 22 12 NSSP =  142 DELTA =  0.0094 EPSS = 2.80 W = 1.70 UW = 1.00
ITER =   270 CIR =     0.31659 DPM =     0.0000434 AT 22 12 NSSP =  143 DELTA =  0.0095 EPSS = 2.70 W = 1.70 UW = 1.00
ITER =   280 CIR =     0.31815 DPM =     0.0000427 AT 22 12 NSSP =  143 DELTA =  0.0096 EPSS = 2.60 W = 1.70 UW = 1.00
ITER =   290 CIR =     0.31772 DPM =     0.0000418 AT 22 12 NSSP =  144 DELTA =  0.0097 EPSS = 2.50 W = 1.70 UW = 1.00
ITER =   300 CIR =     0.31732 DPM =     0.0000407 AT 22 12 NSSP =  144 DELTA =  0.0098 EPSS = 2.40 W = 1.70 UW = 1.00
ITER =   310 CIR =     0.31693 DPM =     0.0000395 AT 22 12 NSSP =  144 DELTA =  0.0098 EPSS = 2.30 W = 1.70 UW = 1.00
ITER =   320 CIR =     0.31656 DPM =     0.0000382 AT 22 12 NSSP =  144 DELTA =  0.0099 EPSS = 2.20 W = 1.70 UW = 1.00
ITER =   330 CIR =     0.31621 DPM =     0.0000368 AT 22 12 NSSP =  144 DELTA =  0.0099 EPSS = 2.10 W = 1.70 UW = 1.00
ITER =   340 CIR =     0.31588 DPM =     0.0000353 AT 22 12 NSSP =  144 DELTA =  0.0100 EPSS = 2.00 W = 1.70 UW = 1.00
ITER =   350 CIR =     0.31557 DPM =     0.0000337 AT 22 12 NSSP =  144 DELTA =  0.0100 EPSS = 1.90 W = 1.70 UW = 1.00
ITER =   360 CIR =     0.31523 DPM =     0.0000322 AT 22 12 NSSP =  144 DELTA =  0.0100 EPSS = 1.80 W = 1.70 UW = 1.00
ITER =   370 CIR =     0.31501 DPM =     0.0000306 AT 22 12 NSSP =  144 DELTA =  0.0101 EPSS = 1.70 W = 1.70 UW = 1.00
ITER =   380 CIR =     0.31475 DPM =     0.0000291 AT 22 12 NSSP =  144 DELTA =  0.0101 EPSS = 1.60 W = 1.70 UW = 1.00
ITER =   390 CIR =     0.31451 DPM =     0.0000275 AT 20 12 NSSP =  144 DELTA =  0.0101 EPSS = 1.50 W = 1.70 UW = 1.00
ITER =   400 CIR =     0.31429 DPM =     0.0000262 AT 20 12 NSSP =  144 DELTA =  0.0101 EPSS = 1.40 W = 1.70 UW = 1.00
ITER =   410 CIR =     0.31408 DPM =     0.0000248 AT 20 12 NSSP =  144 DELTA =  0.0101 EPSS = 1.40 W = 1.70 UW = 1.00
ITER =   420 CIR =     0.31388 DPM =     0.0000234 AT 20 12 NSSP =  144 DELTA =  0.0102 EPSS = 1.40 W = 1.70 UW = 1.00
ITER =   430 CIR =     0.31370 DPM =     0.0000220 AT 20 12 NSSP =  144 DELTA =  0.0102 EPSS = 1.40 W = 1.70 UW = 1.00
ITER =   440 CIR =     0.31354 DPM =     0.0000207 AT 20 12 NSSP =  144 DELTA =  0.0102 EPSS = 1.40 W = 1.70 UW = 1.00
ITER =   450 CIR =     0.31338 DPM =     0.0000195 AT 20 12 NSSP =  144 DELTA =  0.0102 EPSS = 1.40 W = 1.70 UW = 1.00
ITER =   460 CIR =     0.31323 DPM =     0.0000183 AT 20 12 NSSP =  143 DELTA =  0.0102 EPSS = 1.40 W = 1.70 UW = 1.00
ITER =   470 CIR =     0.31307 DPM =     0.0000177 AT 22 12 NSSP =  143 DELTA =  0.0102 EPSS = 1.40 W = 1.70 UW = 1.00
ITER =   480 CIR =     0.31291 DPM =     0.0000171 AT 22 12 NSSP =  144 DELTA =  0.0102 EPSS = 1.40 W = 1.70 UW = 1.00
ITER =   490 CIR =     0.31276 DPM =     0.0000166 AT 22 12 NSSP =  144 DELTA =  0.0102 EPSS = 1.40 W = 1.70 UW = 1.00
ITER =   500 CIR =     0.31262 DPM =     0.0000160 AT 22 12 NSSP =  144 DELTA =  0.0102 EPSS = 1.40 W = 1.70 UW = 1.00
ITER =   510 CIR =     0.31247 DPM =     0.0000155 AT 22 12 NSSP =  144 DELTA =  0.0102 EPSS = 1.40 W = 1.70 UW = 1.00
ITER =   520 CIR =     0.31234 DPM =     0.0000149 AT 22 12 NSSP =  144 DELTA =  0.0102 EPSS = 1.40 W = 1.70 UW = 1.00
ITER =   530 CIR =     0.31220 DPM =     0.0000144 AT 22 12 NSSP =  144 DELTA =  0.0102 EPSS = 1.40 W = 1.70 UW = 1.00
ITER =   540 CIR =     0.31208 DPM =     0.0000133 AT 22 12 NSSP =  144 DELTA =  0.0102 EPSS = 1.40 W = 1.70 UW = 1.00
ITER =   550 CIR =     0.31196 DPM =     0.0000133 AT 22 12 NSSP =  144 DELTA =  0.0102 EPSS = 1.40 W = 1.70 UW = 1.00
ITER =   560 CIR =     0.31184 DPM =     0.0000128 AT 22 12 NSSP =  144 DELTA =  0.0102 EPSS = 1.40 W = 1.70 UW = 1.00
ITER =   570 CIR =     0.31173 DPM =     0.0000123 AT 22 12 NSSP =  144 DELTA =  0.0103 EPSS = 1.40 W = 1.70 UW = 1.00
ITER =   580 CIR =     0.31162 DPM =     0.0000113 AT 22 12 NSSP =  144 DELTA =  0.0103 EPSS = 1.40 W = 1.70 UW = 1.00
ITER =   590 CIR =     0.31152 DPM =     0.0000113 AT 22 12 NSSP =  144 DELTA =  0.0103 EPSS = 1.40 W = 1.70 UW = 1.00
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ITER =  600 CIR =   0.31143 DPM =  0.0000108 AT 22 12 NSSP =  144 DELTA =  0.0103 EPSS = 1.40 W = 1.70 UW = 1.00
ITER =  610 CIR =   0.31134 DPM =  0.0000103 AT 22 12 NSSP =  144 DELTA =  0.0103 EPSS = 1.40 W = 1.70 UW = 1.00
ITER =  620 CIR =   0.31125 DPM =  0.0000099 AT 22 12 NSSP =  144 DELTA =  0.0103 EPSS = 1.40 W = 1.70 UW = 1.00
ITER =  630 CIR =   0.31117 DPM =  0.0000094 AT 22 12 NSSP =  144 DELTA =  0.0103 EPSS = 1.40 W = 1.70 UW = 1.00
ITER =  640 CIR =   0.31109 DPM =  0.0000090 AT 22 12 NSSP =  144 DELTA =  0.0103 EPSS = 1.40 W = 1.70 UW = 1.00
ITER =  650 CIR =   0.31101 DPM =  0.0000086 AT 22 12 NSSP =  144 DELTA =  0.0103 EPSS = 1.40 W = 1.70 UW = 1.00
ITER =  660 CIR =   0.31094 DPM =  0.0000082 AT 22 12 NSSP =  144 DELTA =  0.0103 EPSS = 1.40 W = 1.70 UW = 1.00
ITER =  670 CIR =   0.31087 DPM =  0.0000079 AT 22 12 NSSP =  144 DELTA =  0.0103 EPSS = 1.40 W = 1.70 UW = 1.00
ITER =  680 CIR =   0.31080 DPM =  0.0000075 AT 22 12 NSSP =  144 DELTA =  0.0103 EPSS = 1.40 W = 1.70 UW = 1.00
ITER =  690 CIR =   0.31074 DPM =  0.0000072 AT 22 12 NSSP =  144 DELTA =  0.0103 EPSS = 1.40 W = 1.70 UW = 1.00
ITER =  700 CIR =   0.31068 DPM =  0.0000068 AT 22 12 NSSP =  144 DELTA =  0.0103 EPSS = 1.40 W = 1.70 UW = 1.00
ITER =  710 CIR =   0.31062 DPM =  0.0000065 AT 22 12 NSSP =  144 DELTA =  0.0103 EPSS = 1.40 W = 1.70 UW = 1.00
ITER =  720 CIR =   0.31057 DPM =  0.0000062 AT 22 12 NSSP =  144 DELTA =  0.0103 EPSS = 1.40 W = 1.70 UW = 1.00
ITER =  730 CIR =   0.31052 DPM =  0.0000059 AT 22 12 NSSP =  144 DELTA =  0.0103 EPSS = 1.40 W = 1.70 UW = 1.00
ITER =  740 CIR =   0.31047 DPM =  0.0000057 AT 22 12 NSSP =  144 DELTA =  0.0103 EPSS = 1.40 W = 1.70 UW = 1.00
ITER =  750 CIR =   0.31042 DPM =  0.0000054 AT 22 12 NSSP =  144 DELTA =  0.0103 EPSS = 1.40 W = 1.70 UW = 1.00
ITER =  760 CIR =   0.31038 DPM =  0.0000051 AT 22 12 NSSP =  144 DELTA =  0.0103 EPSS = 1.40 W = 1.70 UW = 1.00
ITER =  770 CIR =   0.31033 DPM =  0.0000049 AT 22 12 NSSP =  144 DELTA =  0.0103 EPSS = 1.40 W = 1.70 UW = 1.00
ITER =  780 CIR =   0.31029 DPM =  0.0000047 AT 22 12 NSSP =  144 DELTA =  0.0103 EPSS = 1.40 W = 1.70 UW = 1.00
ITER =  790 CIR =   0.31026 DPM =  0.0000045 AT 22 12 NSSP =  144 DELTA =  0.0103 EPSS = 1.40 W = 1.70 UW = 1.00
ITER =  800 CIR =   0.31022 DPM =  0.0000042 AT 22 12 NSSP =  144 DELTA =  0.0103 EPSS = 1.40 W = 1.70 UW = 1.00
ITER =  810 CIR =   0.31018 DPM =  0.0000040 AT 22 12 NSSP =  144 DELTA =  0.0103 EPSS = 1.40 W = 1.70 UW = 1.00
ITER =  820 CIR =   0.31015 DPM =  0.0000039 AT 22 12 NSSP =  144 DELTA =  0.0103 EPSS = 1.40 W = 1.70 UW = 1.00
ITER =  830 CIR =   0.31012 DPM =  0.0000037 AT 22 12 NSSP =  144 DELTA =  0.0103 EPSS = 1.40 W = 1.70 UW = 1.00
ITER =  840 CIR =   0.31009 DPM =  0.0000035 AT 22 12 NSSP =  144 DELTA =  0.0103 EPSS = 1.40 W = 1.70 UW = 1.00
ITER =  850 CIR =   0.31006 DPM =  0.0000033 AT 22 12 NSSP =  144 DELTA =  0.0103 EPSS = 1.40 W = 1.70 UW = 1.00
ITER =  860 CIR =   0.31003 DPM =  0.0000032 AT 22 12 NSSP =  144 DELTA =  0.0103 EPSS = 1.40 W = 1.70 UW = 1.00
ITER =  870 CIR =   0.31001 DPM =  0.0000030 AT 22 12 NSSP =  144 DELTA =  0.0103 EPSS = 1.40 W = 1.70 UW = 1.00
ITER =  880 CIR =   0.30998 DPM =  0.0000029 AT 22 12 NSSP =  144 DELTA =  0.0103 EPSS = 1.40 W = 1.70 UW = 1.00
ITER =  890 CIR =   0.30996 DPM =  0.0000027 AT 22 12 NSSP =  144 DELTA =  0.0103 EPSS = 1.40 W = 1.70 UW = 1.00
ITER =  900 CIR =   0.30993 DPM =  0.0000026 AT 22 12 NSSP =  144 DELTA =  0.0103 EPSS = 1.40 W = 1.70 UW = 1.00
ITER =  910 CIR =   0.30991 DPM =  0.0000025 AT 22 12 NSSP =  144 DELTA =  0.0103 EPSS = 1.40 W = 1.70 UW = 1.00
ITER =  920 CIR =   0.30989 DPM =  0.0000024 AT 22 12 NSSP =  144 DELTA =  0.0103 EPSS = 1.40 W = 1.70 UW = 1.00
ITER =  930 CIR =   0.30987 DPM =  0.0000023 AT 22 12 NSSP =  144 DELTA =  0.0103 EPSS = 1.40 W = 1.70 UW = 1.00
ITER =  940 CIR =   0.30985 DPM =  0.0000022 AT 22 12 NSSP =  144 DELTA =  0.0103 EPSS = 1.40 W = 1.70 UW = 1.00
ITER =  950 CIR =   0.30984 DPM =  0.0000021 AT 22 12 NSSP =  144 DELTA =  0.0103 EPSS = 1.40 W = 1.70 UW = 1.00
ITER =  957 CIR =   0.30983 DPM =  0.0000020 AT 22 12 NSSP =  144 DELTA =  0.0103 EPSS = 1.40 W = 1.70 UW = 1.00
BOUNDARY LAYER ANALYSIS FOR REYNOLDS NUMBER OF   0.210E+08

      X        YUORIG      DU        SLU       YLORIG      DL        SLL
  -0.49000    0.01962   0.00000   0.88006   -0.01774   0.00000   -0.89823
  -0.43067    0.04183   0.00008   0.15352   -0.04086   0.00008   -0.18359
  -0.37058    0.05043   0.00021   0.12293   -0.05112   0.00021   -0.14512
  -0.30982    0.05597   0.00036   0.07131   -0.05769   0.00036   -0.08588
  -0.24852    0.05939   0.00051   0.04500   -0.06181   0.00051   -0.05247
  -0.18677    0.06127   0.00064   0.02043   -0.06390   0.00065   -0.02195
  -0.12470    0.06173   0.00076  -0.00029   -0.06435   0.00080    0.00320
  -0.06240    0.06103   0.00086  -0.01665   -0.06306   0.00096    0.03448
   0.00000    0.05917   0.00100  -0.03690   -0.05957   0.00117    0.07052
   0.06240    0.05618   0.00111  -0.05596   -0.05360   0.00148    0.11296
   0.12470    0.05198   0.00122  -0.07491   -0.04475   0.00192    0.15412
   0.18677    0.04663   0.00132  -0.09505   -0.03388   0.00250    0.17158
   0.24852    0.03991   0.00144  -0.11375   -0.02272   0.00319    0.16438
   0.30982    0.03171   0.00163  -0.14215   -0.01279   0.00389    0.13236
   0.37058    0.02205   0.00267  -0.12955   -0.00595   0.00426    0.07888
   0.43067    0.01090   0.00649  -0.12927   -0.00436   0.00376   -0.02390
   0.49000   -0.00204   0.01027  -0.17576   -0.01058   0.00326   -0.17109
 CP BY CENTRAL DIFFERENCES
X              CPU       CPL
  -0.49000    0.15809   0.23234
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-0.43067   -0.62700   -0.45389
-0.37058   -0.64399   -0.36672
-0.30982   -0.70744   -0.43582
-0.24852   -0.74332   -0.43017
-0.18677   -0.78583   -0.38943
-0.12470   -0.82578   -0.35270
-0.06240   -0.86562   -0.32338
 0.00000   -0.90393   -0.24145
 0.06240   -0.95382   -0.09764
 0.12470   -1.00091    0.10271
 0.18677   -1.05740    0.32079
 0.24852   -1.11687    0.50165
 0.30982   -1.13641    0.64575
 0.37059   -1.09891    0.76109
 0.43067   -1.02246    0.94759
 0.49000   -0.07880    0.44885
 0.64714    0.14639    0.14641
 1.40979    0.10360    0.10360
 3.37231    0.15328    0.15330
 X          YU          YL          SLU         SLL
-0.49000    0.01962   -0.01774    0.88006   -0.89823
-0.43067    0.04191   -0.04094    0.15352   -0.18359
-0.37058    0.05069   -0.05134    0.12293   -0.14512
-0.30982    0.05634   -0.05805    0.07131   -0.08588
-0.24852    0.05989   -0.06232    0.04500   -0.05247
-0.18677    0.06190   -0.06455    0.02043   -0.02195
-0.12470    0.06249   -0.06515   -0.00029    0.00320
-0.06240    0.06191   -0.06403   -0.01565    0.03448
 0.00000    0.06017   -0.06075   -0.03690    0.07052
 0.06240    0.05729   -0.05509   -0.05596    0.11296
 0.12470    0.05319   -0.04669   -0.07491    0.15412
 0.18677    0.04795   -0.03642   -0.09505    0.17158
 0.24852    0.04136   -0.02595   -0.11975    0.16438
 0.30982    0.03335   -0.01670   -0.14215    0.13236
 0.37058    0.02474   -0.01022   -0.12955    0.07383
 0.43067    0.01744   -0.00612   -0.12927   -0.02390
 0.49000    0.00339   -0.01389   -0.17576   -0.17109
1
 73 73 74 76 77 79 80 80 81 82 82 83 83 83 84 84 84 84 84 85 87 86 75
 71 70 72 74 75 77 78 78 79 80 80 81 81 82 82 82 83 83 83 84 85 85 77
 70 63 69 69 69 69 69 69 68 68 67 66 68 70 72 74 75 77 78 80 82 85 81
 70 70 72 72 71 71 70 69 69 71 90  0 83 74 73 74 76 78 81 83 86 89 82
 70 71 74 77 79 82 86 90 95109  0  0  0117104 99 95 93 91 90 90 90 81
 71 71 75 79 83 88 92 95 99105  0  0  0113112108104101 98 95 94 92 82
 71 71 76 81 86 91 96100104105  0  0  0121117114110107103100 97 94 83
 71 72 77 83 88 93 97101105103  0  0  0123120118115112108104101 96 83
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 71 72 76 81 86 90 94 97100103  0  0  0129127126124122119115110102 84
 71 71 76 80 84 87 90 93 96 99  0  0  0131130128126124121118113103 85
 71 71 74 78 81 83 86 88 90 93  0  0  0134132130128126123120115105 85
 71 71 73 76 77 79 80 82 83 85  0  0  0137134133131128126122117107 85
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 71 70 71 72 72 72 71 71 70 70 69  0  0144140138136133130126121111 86
 71 70 71 71 70 69 68 67 66 65 63  0  0145142140138135132128123112 86
 71 70 70 70 69 68 66 65 63 61 58  0143144144142140137134130124113 86
 71 70 70 70 69 68 66 65 63 60 54  0138140142144144143140135128115 85
 71 70 70 70 70 70 70 70 70 71 71  0 92 96 98101104107110112113110 85
 71 71 73 75 76 78 79 80 81 81 82 83 84 85 86 86 87 88 89 91 93 93 82
 72 72 75 77 79 80 82 83 83 84 84 85 85 86 86 86 86 86 87 87 88 88 78
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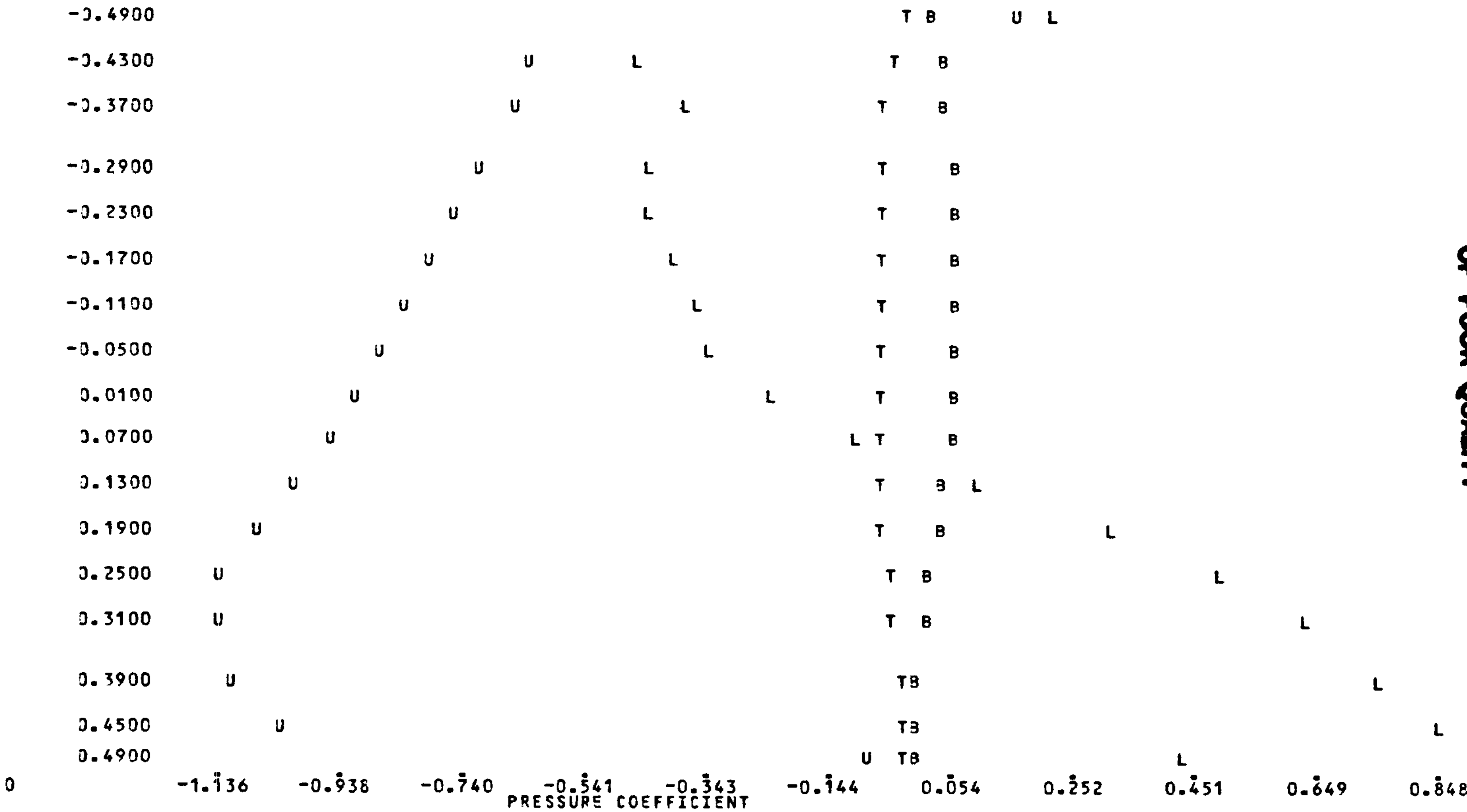
0 69 71 73 75 76 76 79 80 80 81 82 83 83 84 84 85 85 85 86 86 88 88 79
WAVE CD = 0.050001 CDCORR = 0.000000
1 NASA AIRFOIL IN NON-UNIFORM FLOW (NASA ORIGINAL)



CPSTAR = -0.2443 CLCIR = 0.6197

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 FINAL EPSS =    1.400000
1
  FREESTREAM MACH NUMBER PROFILE
     0.8000     0.8000     0.8000     0.8000     0.8000     0.8201     0.8579     0.9079     0.9106     0.9093     0.9185     0.9239     0.9231
     0.9259     0.9294     0.9320     0.9334     0.9337     0.9331     0.9316     0.9297     0.9279     0.9263     0.9247     0.9230     0.9209
     0.9185     0.9161     0.9140     0.9122     0.9109     0.9101     0.9099     0.9102     0.9104     0.9089     0.9078     0.9099     0.8831
     0.8463     0.8555     0.8085     0.8000     0.8000     0.8000     0.8000     0.8000     0.8000     0.8000

  FREESTREAM STAGNATION TEMPERATURE PROFILE
     1.1280     1.1280     1.1280     1.1280     1.1280     1.1345     1.1472     1.1649     1.1659     1.1653     1.1687     1.1707     1.1704
     1.1714     1.1728     1.1737     1.1742     1.1744     1.1741     1.1736     1.1729     1.1722     1.1716     1.1710     1.1704     1.1696
     1.1687     1.1679     1.1671     1.1664     1.1659     1.1657     1.1656     1.1657     1.1658     1.1652     1.1648     1.1656     1.1560
     1.1433     1.1464     1.1307     1.1280     1.1280     1.1280     1.1280     1.1280     1.1280     1.1280

  MACH NUMBER DIVIDED BY SQRT(STAGNATION TEMPERATURE)
     0.7532     0.7532     0.7532     0.7532     0.7532     0.7699     0.8010     0.8412     0.8434     0.8423     0.8496     0.8539     0.8532
     0.8554     0.8562     0.8602     0.8614     0.8616     0.8611     0.8600     0.8585     0.8570     0.8558     0.8546     0.8532     0.8515
     0.8496     0.8478     0.8461     0.8446     0.8436     0.8430     0.8428     0.8431     0.8432     0.8420     0.8411     0.8428     0.8214
     0.7915     0.7990     0.7604     0.7532     0.7532     0.7532     0.7532     0.7532     0.7532     0.7532
1
 NASA AIRFOIL IN NON-UNIFORM FLOW ( NASA ORIGINAL )
0   MACH NO. IS 0.800 ANGLE OF ATTACK IS     0.000 DEGREES
            DIRECT SOLUTION TO      0.50
0   INVISCID ANALYSIS CASE
    WITH VISCOUS INTERACTION
  0.80000    0.00000    0.30983    0.00000 20950000.00000
  0.24600    0.15000    3.87000    0.49000    2.00000
   0    0     1    0     0    0     0    0
  49   49     2 3200  6000
   0    0    0.00400    0.44000    0.10000   -0.44000
   1    2     1    0
        3 0.0000010 2000.00000   50.00000    1.00000    5.00000
  1.40000    1.00000    0.10000    0.12500
  0.00000    5.00000    1.40000

                   X-Y GRID SYSTEM

    1 -0.1565E+02    2 -0.8027E+01    3 -0.3872E+01    4 -0.2276E+01    5 -0.1410E+01    6 -0.9115E+00    7 -0.6471E+00
    8 -0.5317E+00    9 -0.4900E+00   10 -0.4604E+00   11 -0.4307E+00   12 -0.4007E+00   13 -0.3706E+00   14 -0.3403E+00
   15 -0.3098E+00   16 -0.2792E+00   17 -0.2485E+00   18 -0.2177E+00   19 -0.1868E+00   20 -0.1558E+00   21 -0.1247E+00
   22 -0.9357E-01   23 -0.6240E-01   24 -0.3121E-01   25  0.0000E+01   26  0.3121E-01   27  0.6240E-01   28  0.9357E-01
   29  0.1247E+00   30  0.1558E+00   31  0.1869E+00   32  0.2177E+00   33  0.2485E+00   34  0.2792E+00   35  0.3098E+00
   36  0.3403E+00   37  0.3706E+00   38  0.4007E+00   39  0.4307E+00   40  0.4604E+00   41  0.4900E+00   42  0.5317E+00
   43  0.6471E+00   44  0.9115E+00   45  0.1410E+01   46  0.2276E+01   47  0.3872E+01   48  0.8027E+01   49  0.1565E+02
    1 -0.7515E+01    2 -0.3753E+01    3 -0.1869E+01    4 -0.1237E+01    5 -0.9181E+00    6 -0.7247E+00    7 -0.5939E+00
    8 -0.4988E+00    9 -0.4261E+00   10 -0.3682E+00   11 -0.3206E+00   12 -0.2805E+00   13 -0.2460E+00   14 -0.2157E+00
   15 -0.1888E+00   16 -0.1644E+00   17 -0.1420E+00   18 -0.1213E+00   19 -0.1019E+00   20 -0.8351E-01   21 -0.6592E-01
   22 -0.4893E-01   23 -0.3239E-01   24 -0.1612E-01   25 -0.1441E-10   26  0.1612E-01   27  0.3239E-01   28  0.4893E-01
   29  0.6592E-01   30  0.8351E-01   31  0.1019E+00   32  0.1213E+00   33  0.1420E+00   34  0.1644E+00   35  0.1888E+00
   36  0.2157E+00   37  0.2460E+00   38  0.2805E+00   39  0.3206E+00   40  0.3682E+00   41  0.4261E+00   42  0.4988E+00
   43  0.5939E+00   44  0.7247E+00   45  0.9181E+00   46  0.1237E+01   47  0.1869E+01   48  0.3753E+01   49  0.7515E+01
0                      AIRFOIL COORDINATES
      X          YU         YL      UPPER SLOPE LOWER SLOPE
  -0.49000    0.01962   -0.01774    0.88006   -0.89823
  -0.46044    0.03457   -0.03282    0.31220   -0.33716
  -0.43067    0.04191   -0.04094    0.15352   -0.18359
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ORIGINAL PAGE IS
OF POOR QUALITY

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-0.43072   0.04630  -0.04614   0.13823  -0.16436
-0.37058   0.05069  -0.05134   0.12293  -0.14512
-0.34028   0.05351  -0.05469   0.09712  -0.11550
-0.30982   0.05634  -0.05805   0.07131  -0.08588
-0.27923   0.05811  -0.06019   0.05816  -0.06917
-0.24852   0.05939  -0.06232   0.04500  -0.05247
-0.21769   0.06090  -0.06344   0.03272  -0.03721
-0.18677   0.06190  -0.06455   0.02043  -0.02195
-0.15577   0.06220  -0.06485   0.01007  -0.00937
-0.12470   0.06249  -0.06515  -0.00029   0.00320
-0.09357   0.06220  -0.06459  -0.00947   0.01884
-0.06240   0.06191  -0.06403  -0.01865   0.03448
-0.03121   0.06104  -0.06239  -0.02778   0.05250
 0.00000   0.06017  -0.06075  -0.03690   0.07052
 0.03121   0.05873  -0.05792  -0.04643   0.09174
 0.06240   0.05729  -0.05509  -0.05596   0.11296
 0.09357   0.05524  -0.05089  -0.06543   0.13354
 0.12470   0.05319  -0.04669  -0.07491   0.15412
 0.15577   0.05057  -0.04155  -0.08498   0.16285
 0.18677   0.04795  -0.03642  -0.09505   0.17158
 0.21769   0.04465  -0.03119  -0.10690   0.16798
 0.24852   0.04136  -0.02595  -0.11875   0.16438
 0.27923   0.03736  -0.02133  -0.13045   0.14837
 0.30982   0.03335  -0.01670  -0.14215   0.13236
 0.34028   0.02905  -0.01346  -0.13585   0.10562
 0.37058   0.02474  -0.01022  -0.12955   0.07888
 0.40072   0.02109  -0.00917  -0.12941   0.02749
 0.43067   0.01744  -0.00812  -0.12927  -0.02390
 0.46044   0.01291  -0.01101  -0.15251  -0.09750
 0.49000   0.00639  -0.01389  -0.17576  -0.17109
 BEGINNING EPSS=   5.00000  BEGINNING RDEL=   0.05000
BEGIN NEWF
AT ITERATION =     10
BEGIN VISACT
AT ITERATION =     10
ITER =    10 CIR =    0.30618 DPM =   0.0022207 AT 42 40 NSSP =  554 DELTA =  0.0103 EPSS = 5.00 W = 1.40 UW = 1.00
ACCEPTABLE REGION FOR ANALYSIS
AT ITERATION =     13
STABLE REGION
AT ITERATION =     20
ITER =    20 CIR =    0.30454 DPM =   0.0004516 AT 39 47 NSSP =  567 DELTA =  0.0102 EPSS = 5.00 W = 1.45 UW = 1.00
ITER =    30 CIR =    0.30279 DPM =   0.0003413 AT  7 48 NSSP =  571 DELTA =  0.0105 EPSS = 4.90 W = 1.50 UW = 1.00
ITER =    40 CIR =    0.30002 DPM =   0.0002987 AT 42 42 NSSP =  564 DELTA =  0.0108 EPSS = 4.80 W = 1.55 UW = 1.00
ITER =    50 CIR =    0.29742 DPM =   0.0002055 AT 48 24 NSSP =  565 DELTA =  0.0111 EPSS = 4.70 W = 1.55 UW = 1.00
ITER =    60 CIR =    0.29527 DPM =   0.0001642 AT 48 24 NSSP =  564 DELTA =  0.0114 EPSS = 4.60 W = 1.60 UW = 1.00
ITER =    70 CIR =    0.29355 DPM =   0.0001338 AT 48 24 NSSP =  561 DELTA =  0.0118 EPSS = 4.50 W = 1.65 UW = 1.00
ITER =    80 CIR =    0.29210 DPM =   0.0001195 AT  6 48 NSSP =  560 DELTA =  0.0121 EPSS = 4.40 W = 1.70 UW = 1.00
ITER =    90 CIR =    0.29083 DPM =   0.0001017 AT 48 24 NSSP =  561 DELTA =  0.0124 EPSS = 4.30 W = 1.70 UW = 1.00
ITER =   100 CIR =    0.28967 DPM =   0.0000942 AT 42 24 NSSP =  561 DELTA =  0.0127 EPSS = 4.20 W = 1.70 UW = 1.00
ITER =   110 CIR =    0.28856 DPM =   0.0000922 AT 48 24 NSSP =  564 DELTA =  0.0129 EPSS = 4.10 W = 1.70 UW = 1.00
ITER =   120 CIR =    0.28727 DPM =   0.0001233 AT 48 24 NSSP =  561 DELTA =  0.0131 EPSS = 4.00 W = 1.70 UW = 1.00
ITER =   130 CIR =    0.28556 DPM =   0.0001728 AT 48 24 NSSP =  560 DELTA =  0.0132 EPSS = 4.10 W = 1.70 UW = 1.00
ITER =   140 CIR =    0.28342 DPM =   0.0002163 AT 48 24 NSSP =  559 DELTA =  0.0133 EPSS = 4.20 W = 1.70 UW = 1.00
ITER =   150 CIR =    0.28119 DPM =   0.0002122 AT 48 24 NSSP =  559 DELTA =  0.0133 EPSS = 4.30 W = 1.70 UW = 1.00
ITER =   160 CIR =    0.27934 DPM =   0.0001848 AT 48 24 NSSP =  560 DELTA =  0.0133 EPSS = 4.40 W = 1.70 UW = 1.00
ITER =   170 CIR =    0.27801 DPM =   0.0001287 AT 48 24 NSSP =  561 DELTA =  0.0131 EPSS = 4.30 W = 1.70 UW = 1.00
ITER =   180 CIR =    0.27709 DPM =   0.0000943 AT 48 24 NSSP =  561 DELTA =  0.0128 EPSS = 4.20 W = 1.70 UW = 1.00
ITER =   190 CIR =    0.27642 DPM =   0.0000392 AT 38 24 NSSP =  560 DELTA =  0.0126 EPSS = 4.10 W = 1.70 UW = 1.00
ITER =   200 CIR =    0.27590 DPM =   0.0000853 AT 35 23 NSSP =  561 DELTA =  0.0124 EPSS = 4.00 W = 1.70 UW = 1.00
ITER =   210 CIR =    0.27553 DPM =   0.0000819 AT 34 23 NSSP =  562 DELTA =  0.0122 EPSS = 3.90 W = 1.70 UW = 1.00
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ITER =   220 CIR =    0.27525 DPM =    0.0000796 AT 25 21 NSSP =   563 DELTA =   0.0121 EPSS = 3.80 W = 1.70 UW = 1.00
ITER =   230 CIR =    0.27504 DPM =    0.0000775 AT 25 21 NSSP =   564 DELTA =   0.0119 EPSS = 3.81 W = 1.70 UW = 1.00
ITER =   240 CIR =    0.27487 DPM =    0.0000752 AT 25 21 NSSP =   566 DELTA =   0.0118 EPSS = 3.82 W = 1.70 UW = 1.00
ITER =   250 CIR =    0.27474 DPM =    0.0000728 AT 25 21 NSSP =   566 DELTA =   0.0117 EPSS = 3.82 W = 1.70 UW = 1.00
ITER =   260 CIR =    0.27462 DPM =    0.0000711 AT 24 21 NSSP =   565 DELTA =   0.0116 EPSS = 3.72 W = 1.70 UW = 1.00
ITER =   270 CIR =    0.27450 DPM =    0.0000693 AT 24 21 NSSP =   565 DELTA =   0.0115 EPSS = 3.62 W = 1.70 UW = 1.00
ITER =   280 CIR =    0.27429 DPM =    0.0000672 AT 24 21 NSSP =   566 DELTA =   0.0116 EPSS = 3.52 W = 1.70 UW = 1.00
ITER =   290 CIR =    0.27404 DPM =    0.0000650 AT 24 21 NSSP =   565 DELTA =   0.0116 EPSS = 3.42 W = 1.70 UW = 1.00
ITER =   300 CIR =    0.27376 DPM =    0.0000628 AT 24 21 NSSP =   565 DELTA =   0.0116 EPSS = 3.32 W = 1.70 UW = 1.00
ITER =   310 CIR =    0.27347 DPM =    0.0000607 AT 24 21 NSSP =   565 DELTA =   0.0117 EPSS = 3.22 W = 1.70 UW = 1.00
ITER =   320 CIR =    0.27318 DPM =    0.0000587 AT 23 21 NSSP =   565 DELTA =   0.0117 EPSS = 3.12 W = 1.70 UW = 1.00
ITER =   330 CIR =    0.27288 DPM =    0.0000569 AT 23 21 NSSP =   565 DELTA =   0.0117 EPSS = 3.02 W = 1.70 UW = 1.00
ITER =   340 CIR =    0.27259 DPM =    0.0000552 AT 23 21 NSSP =   566 DELTA =   0.0118 EPSS = 2.92 W = 1.70 UW = 1.00
ITER =   350 CIR =    0.27230 DPM =    0.0000537 AT 23 21 NSSP =   566 DELTA =   0.0118 EPSS = 2.82 W = 1.70 UW = 1.00
ITER =   360 CIR =    0.27201 DPM =    0.0000521 AT 23 21 NSSP =   566 DELTA =   0.0118 EPSS = 2.72 W = 1.70 UW = 1.00
ITER =   370 CIR =    0.27174 DPM =    0.0000509 AT 24 21 NSSP =   566 DELTA =   0.0118 EPSS = 2.62 W = 1.70 UW = 1.00
ITER =   380 CIR =    0.27147 DPM =    0.0000500 AT 35 23 NSSP =   566 DELTA =   0.0118 EPSS = 2.52 W = 1.70 UW = 1.00
ITER =   390 CIR =    0.27120 DPM =    0.0000491 AT 37 24 NSSP =   565 DELTA =   0.0119 EPSS = 2.42 W = 1.70 UW = 1.00
ITER =   400 CIR =    0.27095 DPM =    0.0000482 AT 35 23 NSSP =   565 DELTA =   0.0119 EPSS = 2.32 W = 1.70 UW = 1.00
ITER =   410 CIR =    0.27071 DPM =    0.0000473 AT 35 23 NSSP =   565 DELTA =   0.0119 EPSS = 2.22 W = 1.70 UW = 1.00
ITER =   420 CIR =    0.27048 DPM =    0.0000464 AT 35 23 NSSP =   565 DELTA =   0.0119 EPSS = 2.12 W = 1.70 UW = 1.00
ITER =   430 CIR =    0.27027 DPM =    0.0000455 AT 35 23 NSSP =   565 DELTA =   0.0119 EPSS = 2.02 W = 1.70 UW = 1.00
ITER =   440 CIR =    0.27017 DPM =    0.0000446 AT 34 23 NSSP =   565 DELTA =   0.0118 EPSS = 1.92 W = 1.70 UW = 1.00
ITER =   450 CIR =    0.27003 DPM =    0.0000433 AT 31 22 NSSP =   566 DELTA =   0.0118 EPSS = 1.82 W = 1.70 UW = 1.00
ITER =   460 CIR =    0.26988 DPM =    0.0000421 AT 34 23 NSSP =   566 DELTA =   0.0119 EPSS = 1.83 W = 1.70 UW = 1.00
ITER =   470 CIR =    0.26973 DPM =    0.0000410 AT 34 23 NSSP =   566 DELTA =   0.0119 EPSS = 1.73 W = 1.70 UW = 1.00
ITER =   480 CIR =    0.26959 DPM =    0.0000401 AT 34 23 NSSP =   566 DELTA =   0.0119 EPSS = 1.63 W = 1.70 UW = 1.00
ITER =   490 CIR =    0.26945 DPM =    0.0000391 AT 34 23 NSSP =   566 DELTA =   0.0119 EPSS = 1.53 W = 1.70 UW = 1.00
ITER =   500 CIR =    0.26932 DPM =    0.0000382 AT 34 23 NSSP =   566 DELTA =   0.0119 EPSS = 1.43 W = 1.70 UW = 1.00
ITER =   510 CIR =    0.26929 DPM =    0.0000373 AT 34 23 NSSP =   566 DELTA =   0.0118 EPSS = 1.40 W = 1.70 UW = 1.00
ITER =   520 CIR =    0.26921 DPM =    0.0000362 AT 26 21 NSSP =   566 DELTA =   0.0118 EPSS = 1.40 W = 1.70 UW = 1.00
ITER =   530 CIR =    0.26912 DPM =    0.0000351 AT 27 21 NSSP =   566 DELTA =   0.0118 EPSS = 1.41 W = 1.70 UW = 1.00
ITER =   540 CIR =    0.26902 DPM =    0.0000341 AT 27 21 NSSP =   566 DELTA =   0.0119 EPSS = 1.40 W = 1.70 UW = 1.00
ITER =   550 CIR =    0.26891 DPM =    0.0000332 AT 28 21 NSSP =   566 DELTA =   0.0119 EPSS = 1.40 W = 1.70 UW = 1.00
ITER =   560 CIR =    0.26881 DPM =    0.0000324 AT 34 23 NSSP =   567 DELTA =   0.0119 EPSS = 1.40 W = 1.70 UW = 1.00
ITER =   570 CIR =    0.26872 DPM =    0.0000316 AT 34 23 NSSP =   567 DELTA =   0.0119 EPSS = 1.40 W = 1.70 UW = 1.00
ITER =   580 CIR =    0.26872 DPM =    0.0000308 AT 34 23 NSSP =   569 DELTA =   0.0118 EPSS = 1.40 W = 1.70 UW = 1.00
ITER =   590 CIR =    0.26868 DPM =    0.0000299 AT 27 21 NSSP =   569 DELTA =   0.0118 EPSS = 1.40 W = 1.70 UW = 1.00
ITER =   600 CIR =    0.26861 DPM =    0.0000289 AT 27 21 NSSP =   569 DELTA =   0.0118 EPSS = 1.41 W = 1.70 UW = 1.00
ITER =   610 CIR =    0.26854 DPM =    0.0000280 AT 27 21 NSSP =   569 DELTA =   0.0119 EPSS = 1.40 W = 1.70 UW = 1.00
ITER =   620 CIR =    0.26846 DPM =    0.0000273 AT 28 21 NSSP =   569 DELTA =   0.0119 EPSS = 1.40 W = 1.70 UW = 1.00
ITER =   630 CIR =    0.26839 DPM =    0.0000266 AT 23 21 NSSP =   569 DELTA =   0.0119 EPSS = 1.40 W = 1.70 UW = 1.00
ITER =   640 CIR =    0.26832 DPM =    0.0000259 AT 34 23 NSSP =   569 DELTA =   0.0119 EPSS = 1.40 W = 1.70 UW = 1.00
ITER =   650 CIR =    0.26835 DPM =    0.0000252 AT 33 23 NSSP =   569 DELTA =   0.0118 EPSS = 1.40 W = 1.70 UW = 1.00
ITER =   660 CIR =    0.26832 DPM =    0.0000245 AT 27 21 NSSP =   570 DELTA =   0.0118 EPSS = 1.40 W = 1.70 UW = 1.00
ITER =   670 CIR =    0.26827 DPM =    0.0000237 AT 25 21 NSSP =   570 DELTA =   0.0119 EPSS = 1.41 W = 1.70 UW = 1.00
ITER =   680 CIR =    0.26821 DPM =    0.0000229 AT 27 21 NSSP =   571 DELTA =   0.0119 EPSS = 1.40 W = 1.70 UW = 1.00
ITER =   690 CIR =    0.26816 DPM =    0.0000222 AT 27 21 NSSP =   571 DELTA =   0.0119 EPSS = 1.40 W = 1.70 UW = 1.00
ITER =   700 CIR =    0.26810 DPM =    0.0000216 AT 28 21 NSSP =   571 DELTA =   0.0119 EPSS = 1.40 W = 1.70 UW = 1.00
ITER =   710 CIR =    0.26813 DPM =    0.0000211 AT 33 23 NSSP =   571 DELTA =   0.0118 EPSS = 1.40 W = 1.70 UW = 1.00
ITER =   720 CIR =    0.26812 DPM =    0.0000205 AT 27 21 NSSP =   571 DELTA =   0.0118 EPSS = 1.40 W = 1.70 UW = 1.00
ITER =   730 CIR =    0.26808 DPM =    0.0000198 AT 25 21 NSSP =   571 DELTA =   0.0119 EPSS = 1.41 W = 1.70 UW = 1.00
ITER =   740 CIR =    0.26804 DPM =    0.0000191 AT 27 21 NSSP =   571 DELTA =   0.0119 EPSS = 1.40 W = 1.70 UW = 1.00
ITER =   750 CIR =    0.26799 DPM =    0.0000185 AT 27 21 NSSP =   571 DELTA =   0.0119 EPSS = 1.40 W = 1.70 UW = 1.00
ITER =   760 CIR =    0.26794 DPM =    0.0000180 AT 28 21 NSSP =   571 DELTA =   0.0119 EPSS = 1.40 W = 1.70 UW = 1.00
ITER =   770 CIR =    0.26799 DPM =    0.0000182 AT 41 26 NSSP =   572 DELTA =   0.0118 EPSS = 1.40 W = 1.70 UW = 1.00
ITER =   780 CIR =    0.26798 DPM =    0.0000171 AT 27 21 NSSP =   572 DELTA =   0.0118 EPSS = 1.41 W = 1.70 UW = 1.00
ITER =   790 CIR =    0.26795 DPM =    0.0000165 AT 25 21 NSSP =   572 DELTA =   0.0118 EPSS = 1.42 W = 1.70 UW = 1.00
ITER =   800 CIR =    0.26791 DPM =    0.0000159 AT 24 21 NSSP =   572 DELTA =   0.0119 EPSS = 1.40 W = 1.70 UW = 1.00
ITER =   810 CIR =    0.26787 DPM =    0.0000154 AT 27 21 NSSP =   572 DELTA =   0.0119 EPSS = 1.40 W = 1.70 UW = 1.00
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ITER =  820 CIR =   0.26792 DPM =   0.0000161 AT 41 26 NSSP =  572 DELTA =  0.0118 EPSS = 1.40 W = 1.70 UW = 1.00
ITER =  830 CIR =   0.26791 DPM =   0.0000146 AT 27 21 NSSP =  572 DELTA =  0.0118 EPSS = 1.41 W = 1.70 UW = 1.00
ITER =  840 CIR =   0.26789 DPM =   0.0000140 AT 25 21 NSSP =  572 DELTA =  0.0118 EPSS = 1.42 W = 1.70 UW = 1.00
ITER =  850 CIR =   0.26785 DPM =   0.0000135 AT 24 21 NSSP =  572 DELTA =  0.0119 EPSS = 1.40 W = 1.70 UW = 1.00
ITER =  860 CIR =   0.26782 DPM =   0.0000131 AT 27 21 NSSP =  572 DELTA =  0.0119 EPSS = 1.40 W = 1.70 UW = 1.00
ITER =  870 CIR =   0.26786 DPM =   0.0000144 AT 41 26 NSSP =  572 DELTA =  0.0118 EPSS = 1.40 W = 1.70 UW = 1.00
ITER =  880 CIR =   0.26786 DPM =   0.0000124 AT 27 21 NSSP =  572 DELTA =  0.0118 EPSS = 1.41 W = 1.70 UW = 1.00
ITER =  890 CIR =   0.26784 DPM =   0.0000119 AT 25 21 NSSP =  572 DELTA =  0.0118 EPSS = 1.42 W = 1.70 UW = 1.00
ITER =  900 CIR =   0.26781 DPM =   0.0000115 AT 24 21 NSSP =  572 DELTA =  0.0119 EPSS = 1.40 W = 1.70 UW = 1.00
ITER =  910 CIR =   0.26777 DPM =   0.0000111 AT 28 21 NSSP =  572 DELTA =  0.0119 EPSS = 1.40 W = 1.70 UW = 1.00
ITER =  920 CIR =   0.26782 DPM =   0.0000129 AT 41 26 NSSP =  572 DELTA =  0.0118 EPSS = 1.40 W = 1.70 UW = 1.00
ITER =  930 CIR =   0.26782 DPM =   0.0000106 AT 27 21 NSSP =  572 DELTA =  0.0118 EPSS = 1.41 W = 1.70 UW = 1.00
ITER =  940 CIR =   0.26781 DPM =   0.0000101 AT 25 21 NSSP =  572 DELTA =  0.0118 EPSS = 1.42 W = 1.70 UW = 1.00
ITER =  950 CIR =   0.26778 DPM =   0.0000097 AT 24 21 NSSP =  572 DELTA =  0.0119 EPSS = 1.40 W = 1.70 UW = 1.00
ITER =  960 CIR =   0.26775 DPM =   0.0000094 AT 27 21 NSSP =  572 DELTA =  0.0119 EPSS = 1.40 W = 1.70 UW = 1.00
ITER =  970 CIR =   0.26780 DPM =   0.0000116 AT 41 26 NSSP =  572 DELTA =  0.0118 EPSS = 1.40 W = 1.70 UW = 1.00
ITER =  980 CIR =   0.26780 DPM =   0.0000090 AT 27 21 NSSP =  572 DELTA =  0.0118 EPSS = 1.41 W = 1.70 UW = 1.00
ITER =  990 CIR =   0.26779 DPM =   0.0000086 AT 25 21 NSSP =  572 DELTA =  0.0118 EPSS = 1.41 W = 1.70 UW = 1.00
ITER = 1000 CIR =   0.26776 DPM =   0.0000082 AT 24 21 NSSP =  572 DELTA =  0.0118 EPSS = 1.40 W = 1.70 UW = 1.00
ITER = 1010 CIR =   0.26782 DPM =   0.0000103 AT 41 26 NSSP =  572 DELTA =  0.0118 EPSS = 1.40 W = 1.70 UW = 1.00
ITER = 1020 CIR =   0.26781 DPM =   0.0000077 AT 27 21 NSSP =  572 DELTA =  0.0118 EPSS = 1.41 W = 1.70 UW = 1.00
ITER = 1030 CIR =   0.26779 DPM =   0.0000074 AT 24 21 NSSP =  572 DELTA =  0.0118 EPSS = 1.41 W = 1.70 UW = 1.00
ITER = 1040 CIR =   0.26776 DPM =   0.0000071 AT 23 21 NSSP =  572 DELTA =  0.0118 EPSS = 1.40 W = 1.70 UW = 1.00
ITER = 1050 CIR =   0.26773 DPM =   0.0000070 AT 42 24 NSSP =  572 DELTA =  0.0119 EPSS = 1.40 W = 1.70 UW = 1.00
ITER = 1060 CIR =   0.26779 DPM =   0.0000094 AT 41 26 NSSP =  572 DELTA =  0.0118 EPSS = 1.40 W = 1.70 UW = 1.00
ITER = 1070 CIR =   0.26779 DPM =   0.0000066 AT 39 27 NSSP =  572 DELTA =  0.0118 EPSS = 1.41 W = 1.70 UW = 1.00
ITER = 1080 CIR =   0.26778 DPM =   0.0000063 AT 25 21 NSSP =  572 DELTA =  0.0118 EPSS = 1.41 W = 1.70 UW = 1.00
ITER = 1090 CIR =   0.26775 DPM =   0.0000061 AT 24 21 NSSP =  572 DELTA =  0.0118 EPSS = 1.40 W = 1.70 UW = 1.00
ITER = 1100 CIR =   0.26781 DPM =   0.0000085 AT 41 26 NSSP =  572 DELTA =  0.0118 EPSS = 1.40 W = 1.70 UW = 1.00
ITER = 1110 CIR =   0.26781 DPM =   0.0000057 AT 27 21 NSSP =  572 DELTA =  0.0118 EPSS = 1.41 W = 1.70 UW = 1.00
ITER = 1120 CIR =   0.26779 DPM =   0.0000055 AT 24 21 NSSP =  572 DELTA =  0.0118 EPSS = 1.40 W = 1.70 UW = 1.00
ITER = 1130 CIR =   0.26776 DPM =   0.0000053 AT 42 24 NSSP =  572 DELTA =  0.0118 EPSS = 1.40 W = 1.70 UW = 1.00
ITER = 1140 CIR =   0.26781 DPM =   0.0000077 AT 41 26 NSSP =  572 DELTA =  0.0118 EPSS = 1.40 W = 1.70 UW = 1.00
ITER = 1150 CIR =   0.26781 DPM =   0.0000050 AT 37 27 NSSP =  572 DELTA =  0.0118 EPSS = 1.41 W = 1.70 UW = 1.00
ITER = 1160 CIR =   0.26779 DPM =   0.0000048 AT 37 27 NSSP =  572 DELTA =  0.0118 EPSS = 1.40 W = 1.70 UW = 1.00
ITER = 1170 CIR =   0.26776 DPM =   0.0000047 AT 42 24 NSSP =  572 DELTA =  0.0118 EPSS = 1.40 W = 1.70 UW = 1.00
ITER = 1180 CIR =   0.26781 DPM =   0.0000071 AT 41 26 NSSP =  572 DELTA =  0.0118 EPSS = 1.40 W = 1.70 UW = 1.00
ITER = 1190 CIR =   0.26781 DPM =   0.0000043 AT 37 27 NSSP =  572 DELTA =  0.0118 EPSS = 1.41 W = 1.70 UW = 1.00
ITER = 1200 CIR =   0.26779 DPM =   0.0000041 AT 36 27 NSSP =  572 DELTA =  0.0118 EPSS = 1.40 W = 1.70 UW = 1.00
ITER = 1210 CIR =   0.26776 DPM =   0.0000041 AT 42 24 NSSP =  572 DELTA =  0.0118 EPSS = 1.40 W = 1.70 UW = 1.00
ITER = 1220 CIR =   0.26782 DPM =   0.0000066 AT 41 26 NSSP =  572 DELTA =  0.0118 EPSS = 1.40 W = 1.70 UW = 1.00
ITER = 1230 CIR =   0.26782 DPM =   0.0000038 AT 37 27 NSSP =  572 DELTA =  0.0118 EPSS = 1.41 W = 1.70 UW = 1.00
ITER = 1240 CIR =   0.26780 DPM =   0.0000036 AT 36 27 NSSP =  572 DELTA =  0.0118 EPSS = 1.40 W = 1.70 UW = 1.00
ITER = 1250 CIR =   0.26777 DPM =   0.0000036 AT 43 24 NSSP =  572 DELTA =  0.0118 EPSS = 1.40 W = 1.70 UW = 1.00
ITER = 1260 CIR =   0.26782 DPM =   0.0000061 AT 41 26 NSSP =  572 DELTA =  0.0118 EPSS = 1.40 W = 1.70 UW = 1.00
ITER = 1270 CIR =   0.26782 DPM =   0.0000033 AT 37 27 NSSP =  572 DELTA =  0.0118 EPSS = 1.41 W = 1.70 UW = 1.00
ITER = 1280 CIR =   0.26780 DPM =   0.0000031 AT 36 27 NSSP =  572 DELTA =  0.0118 EPSS = 1.40 W = 1.70 UW = 1.00
ITER = 1290 CIR =   0.26778 DPM =   0.0000033 AT 43 24 NSSP =  572 DELTA =  0.0118 EPSS = 1.40 W = 1.70 UW = 1.00
ITER = 1300 CIR =   0.26783 DPM =   0.0000057 AT 41 26 NSSP =  572 DELTA =  0.0118 EPSS = 1.40 W = 1.70 UW = 1.00
ITER = 1310 CIR =   0.26783 DPM =   0.0000029 AT 40 35 NSSP =  572 DELTA =  0.0118 EPSS = 1.41 W = 1.70 UW = 1.00
ITER = 1320 CIR =   0.26781 DPM =   0.0000027 AT 36 27 NSSP =  572 DELTA =  0.0118 EPSS = 1.40 W = 1.70 UW = 1.00
ITER = 1330 CIR =   0.26778 DPM =   0.0000029 AT 43 24 NSSP =  572 DELTA =  0.0118 EPSS = 1.40 W = 1.70 UW = 1.00
ITER = 1340 CIR =   0.26783 DPM =   0.0000053 AT 41 26 NSSP =  572 DELTA =  0.0118 EPSS = 1.40 W = 1.70 UW = 1.00
ITER = 1350 CIR =   0.26783 DPM =   0.0000025 AT 40 35 NSSP =  572 DELTA =  0.0118 EPSS = 1.41 W = 1.70 UW = 1.00
ITER = 1360 CIR =   0.26781 DPM =   0.0000024 AT 35 28 NSSP =  572 DELTA =  0.0118 EPSS = 1.40 W = 1.70 UW = 1.00
ITER = 1370 CIR =   0.26778 DPM =   0.0000027 AT 44 24 NSSP =  571 DELTA =  0.0118 EPSS = 1.40 W = 1.70 UW = 1.00
ITER = 1380 CIR =   0.26784 DPM =   0.0000050 AT 41 26 NSSP =  572 DELTA =  0.0118 EPSS = 1.40 W = 1.70 UW = 1.00
ITER = 1390 CIR =   0.26783 DPM =   0.0000022 AT 40 35 NSSP =  572 DELTA =  0.0118 EPSS = 1.41 W = 1.70 UW = 1.00
ITER = 1400 CIR =   0.26782 DPM =   0.0000021 AT 43 24 NSSP =  572 DELTA =  0.0118 EPSS = 1.40 W = 1.70 UW = 1.00
ITER = 1410 CIR =   0.26779 DPM =   0.0000025 AT 45 24 NSSP =  571 DELTA =  0.0118 EPSS = 1.40 W = 1.70 UW = 1.00
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ITER = 1420 CIR =    0.26784 DPM =    0.0000048 AT 41 26 NSSP =   572 DELTA =   0.0118 EPSS = 1.40 W = 1.70 UW = 1.00
ITER = 1430 CIR =    0.26784 DPM =    0.0000020 AT 41 40 NSSP =   572 DELTA =   0.0118 EPSS = 1.41 W = 1.70 UW = 1.00
ITER = 1440 CIR =    0.26782 DPM =    0.0000019 AT 43 24 NSSP =   572 DELTA =   0.0118 EPSS = 1.40 W = 1.70 UW = 1.00
ITER = 1450 CIR =    0.26779 DPM =    0.0000024 AT 48 24 NSSP =   571 DELTA =   0.0118 EPSS = 1.40 W = 1.70 UW = 1.00
ITER = 1460 CIR =    0.26784 DPM =    0.0000046 AT 41 26 NSSP =   572 DELTA =   0.0118 EPSS = 1.40 W = 1.70 UW = 1.00
ITER = 1470 CIR =    0.26784 DPM =    0.0000017 AT 41 40 NSSP =   572 DELTA =   0.0118 EPSS = 1.41 W = 1.70 UW = 1.00
ITER = 1480 CIR =    0.26782 DPM =    0.0000017 AT 44 24 NSSP =   571 DELTA =   0.0118 EPSS = 1.40 W = 1.70 UW = 1.00
ITER = 1490 CIR =    0.26779 DPM =    0.0000023 AT 48 24 NSSP =   571 DELTA =   0.0118 EPSS = 1.40 W = 1.70 UW = 1.00
ITER = 1500 CIR =    0.26785 DPM =    0.0000045 AT 41 26 NSSP =   572 DELTA =   0.0118 EPSS = 1.40 W = 1.70 UW = 1.00
ITER = 1510 CIR =    0.26785 DPM =    0.0000016 AT 41 40 NSSP =   572 DELTA =   0.0118 EPSS = 1.41 W = 1.70 UW = 1.00
ITER = 1520 CIR =    0.26783 DPM =    0.0000016 AT 45 24 NSSP =   571 DELTA =   0.0118 EPSS = 1.40 W = 1.70 UW = 1.00
ITER = 1530 CIR =    0.26780 DPM =    0.0000024 AT 48 24 NSSP =   571 DELTA =   0.0118 EPSS = 1.40 W = 1.70 UW = 1.00
ITER = 1540 CIR =    0.26785 DPM =    0.0000044 AT 41 26 NSSP =   571 DELTA =   0.0118 EPSS = 1.40 W = 1.70 UW = 1.00
ITER = 1550 CIR =    0.26785 DPM =    0.0000014 AT 41 40 NSSP =   572 DELTA =   0.0118 EPSS = 1.41 W = 1.70 UW = 1.00
ITER = 1560 CIR =    0.26783 DPM =    0.0000015 AT 46 24 NSSP =   571 DELTA =   0.0118 EPSS = 1.40 W = 1.70 UW = 1.00
ITER = 1570 CIR =    0.26780 DPM =    0.0000024 AT 43 24 NSSP =   571 DELTA =   0.0118 EPSS = 1.40 W = 1.70 UW = 1.00
ITER = 1580 CIR =    0.26785 DPM =    0.0000042 AT 41 26 NSSP =   571 DELTA =   0.0118 EPSS = 1.40 W = 1.70 UW = 1.00
ITER = 1590 CIR =    0.26785 DPM =    0.0000013 AT 41 40 NSSP =   571 DELTA =   0.0118 EPSS = 1.41 W = 1.70 UW = 1.00
ITER = 1600 CIR =    0.26783 DPM =    0.0000015 AT 47 24 NSSP =   571 DELTA =   0.0118 EPSS = 1.40 W = 1.70 UW = 1.00
ITER = 1610 CIR =    0.26780 DPM =    0.0000023 AT 43 24 NSSP =   571 DELTA =   0.0118 EPSS = 1.40 W = 1.70 UW = 1.00
ITER = 1620 CIR =    0.26786 DPM =    0.0000041 AT 41 26 NSSP =   571 DELTA =   0.0118 EPSS = 1.40 W = 1.70 UW = 1.00
ITER = 1630 CIR =    0.26786 DPM =    0.0000011 AT 41 40 NSSP =   571 DELTA =   0.0118 EPSS = 1.41 W = 1.70 UW = 1.00
ITER = 1640 CIR =    0.26784 DPM =    0.0000016 AT 43 24 NSSP =   571 DELTA =   0.0118 EPSS = 1.40 W = 1.70 UW = 1.00
ITER = 1650 CIR =    0.26781 DPM =    0.0000023 AT 43 24 NSSP =   571 DELTA =   0.0118 EPSS = 1.40 W = 1.70 UW = 1.00
ITER = 1660 CIR =    0.26786 DPM =    0.0000040 AT 41 26 NSSP =   571 DELTA =   0.0118 EPSS = 1.40 W = 1.70 UW = 1.00
ITER = 1670 CIR =    0.26786 DPM =    0.0000010 AT 41 40 NSSP =   571 DELTA =   0.0118 EPSS = 1.41 W = 1.70 UW = 1.00
ITER = 1680 CIR =    0.26784 DPM =    0.0000015 AT 48 24 NSSP =   571 DELTA =   0.0118 EPSS = 1.40 W = 1.70 UW = 1.00
ITER = 1690 CIR =    0.26781 DPM =    0.0000024 AT 43 24 NSSP =   571 DELTA =   0.0118 EPSS = 1.40 W = 1.70 UW = 1.00
ITER = 1700 CIR =    0.26786 DPM =    0.0000039 AT 41 26 NSSP =   571 DELTA =   0.0118 EPSS = 1.40 W = 1.70 UW = 1.00
ITER = 1709 CIR =    0.26786 DPM =    0.0000010 AT 41 40 NSSP =   571 DELTA =   0.0118 EPSS = 1.41 W = 1.70 UW = 1.00
0BOUNDARY LAYER ANALYSIS FOR REYNOLDS NUMBER OF   0.210E+08
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X	YUORIG	DU	SLU	YLORIG	DL	SLL
-0.49000	0.01962	0.00000	0.88006	-0.01774	0.00000	-0.89823
-0.46044	0.03457	0.00001	0.31220	-0.03282	0.00001	-0.33716
-0.43067	0.04183	0.00005	0.19347	-0.04086	0.00005	-0.22766
-0.40072	0.04673	0.00013	0.14202	-0.04663	0.00012	-0.16932
-0.37058	0.05045	0.00021	0.11339	-0.05112	0.00021	-0.13611
-0.34028	0.05350	0.00029	0.09271	-0.05476	0.00029	-0.10967
-0.30982	0.05597	0.00037	0.07366	-0.05769	0.00036	-0.08816
-0.27923	0.05788	0.00044	0.05718	-0.06003	0.00042	-0.06943
-0.24852	0.05938	0.00050	0.04449	-0.06181	0.00049	-0.05136
-0.21769	0.06050	0.00057	0.03276	-0.06308	0.00056	-0.03566
-0.18677	0.06127	0.00063	0.01984	-0.06390	0.00063	-0.02189
-0.15577	0.06162	0.00069	0.00892	-0.06431	0.00069	-0.00924
-0.12470	0.06173	0.00075	0.00119	-0.06435	0.00076	0.00264
-0.09357	0.06155	0.00081	-0.00939	-0.06398	0.00083	0.01757
-0.06240	0.06103	0.00087	-0.01967	-0.06306	0.00091	0.03611
-0.03121	0.06023	0.00093	-0.02806	-0.06157	0.00101	0.05235
0.00000	0.05917	0.00098	-0.03603	-0.05957	0.00113	0.06925
0.03121	0.05784	0.00104	-0.04607	-0.05694	0.00126	0.09067
0.06240	0.05618	0.00109	-0.05539	-0.05360	0.00142	0.11272
0.09357	0.05423	0.00115	-0.06564	-0.04954	0.00163	0.13535
0.12470	0.05198	0.00120	-0.07554	-0.04475	0.00187	0.15500
0.15577	0.04943	0.00125	-0.08415	-0.03945	0.00213	0.16734
0.18677	0.04663	0.00130	-0.09487	-0.03388	0.00241	0.17164
0.21769	0.04344	0.00135	-0.10718	-0.02828	0.00271	0.17193
0.24852	0.03991	0.00140	-0.11897	-0.02272	0.00302	0.16561
0.27923	0.03599	0.00146	-0.13175	-0.01752	0.00334	0.15352
0.30982	0.03171	0.00154	-0.14261	-0.01278	0.00363	0.13505

ORIGINAL PAGE IS
OF POOR QUALITY

0.34028	0.02707	0.00172	-0.14938	-0.00886	0.00385	0.10798
0.37058	0.02205	0.00225	-0.14201	-0.00595	0.00397	0.07538
0.40072	0.01669	0.00369	-0.11626	-0.00434	0.00395	0.03139
0.43067	0.01090	0.00625	-0.10705	-0.00436	0.00373	-0.01823
0.46044	0.00467	0.00904	-0.12255	-0.00631	0.00321	-0.08495
0.49000	-0.00204	0.01182	-0.13977	-0.01058	0.00269	-0.17075

*** WRITE ON DISK LOUT ***

CP BY CENTRAL DIFFERENCES

X	CPU	CPL
-0.49000	0.23210	0.47701
-0.46044	-0.35397	-0.09111
-0.43067	-0.48547	-0.25853
-0.40072	-0.53735	-0.31842
-0.37058	-0.56334	-0.35335
-0.34028	-0.59680	-0.39172
-0.30982	-0.63443	-0.42394
-0.27923	-0.66596	-0.45525
-0.24852	-0.69279	-0.48186
-0.21769	-0.72467	-0.49697
-0.18677	-0.75760	-0.50104
-0.15577	-0.78237	-0.49365
-0.12470	-0.80813	-0.48430
-0.09357	-0.83989	-0.48628
-0.06240	-0.86824	-0.48043
-0.03121	-0.89236	-0.43070
0.00000	-0.91868	-0.34434
0.03121	-0.94364	-0.25646
0.06240	-0.97705	-0.16524
0.09357	-1.00463	-0.05412
0.12470	-1.03107	0.07127
0.15577	-1.05705	0.19611
0.18677	-1.08936	0.30737
0.21769	-1.12353	0.40400
0.24852	-1.15765	0.49254
0.27923	-1.19057	0.57163
0.30982	-1.21484	0.64371
0.34028	-1.21766	0.70354
0.37058	-1.16542	0.75167
0.40072	-1.00720	0.78558
0.43067	-0.38355	0.80185
0.46044	0.14136	0.79399
0.49000	0.23963	0.53663
0.53171	0.30631	0.30634
0.64714	0.23416	0.23418
0.91153	0.16382	0.16382
1.40979	0.11525	0.11525
2.27592	0.09472	0.09473
3.87231	0.09757	0.09757
8.02700	0.16376	0.16379

X	YU	YL	SLU	SLL
-0.49000	0.01962	-0.01774	0.88006	-0.89323
-0.46044	0.03459	-0.03283	0.31220	-0.33716
-0.43067	0.04188	-0.04091	0.19847	-0.22766
-0.40072	0.04686	-0.04676	0.14202	-0.16932
-0.37058	0.05069	-0.05133	0.11339	-0.13611
-0.34028	0.05379	-0.05505	0.09271	-0.10967
-0.30982	0.05634	-0.05804	0.07386	-0.08816
-0.27923	0.05832	-0.06046	0.05718	-0.06943
-0.24852	0.05988	-0.06231	0.04449	-0.05136

ORIGINAL PAGE IS
OF POOR QUALITY

-0.21769	0.06107	-0.06364	0.03276	-0.03566
-0.18677	0.06189	-0.06453	0.01984	-0.02189
-0.15577	0.06231	-0.06501	0.00892	-0.00924
-0.12470	0.06248	-0.06511	0.00119	0.00264
-0.09357	0.06236	-0.06481	-0.00939	0.01757
-0.06240	0.06190	-0.06397	-0.01967	0.03611
-0.03121	0.06115	-0.06258	-0.02806	0.05235
0.00000	0.06015	-0.06070	-0.03603	0.06925
0.03121	0.05888	-0.05821	-0.04607	0.09067
0.06240	0.05727	-0.05504	-0.05639	0.11272
0.09357	0.05538	-0.05113	-0.06564	0.13535
0.12470	0.05318	-0.04664	-0.07554	0.15500
0.15577	0.05069	-0.04161	-0.08415	0.16734
0.18677	0.04793	-0.03633	-0.09487	0.17164
0.21769	0.04480	-0.03103	-0.10713	0.17193
0.24852	0.04132	-0.02578	-0.11897	0.16561
0.27923	0.03747	-0.02089	-0.13175	0.15352
0.30982	0.03327	-0.01644	-0.14261	0.13505
0.34028	0.02881	-0.01273	-0.14938	0.10798
0.37059	0.02433	-0.00993	-0.14201	0.07538
0.40072	0.02041	-0.00829	-0.11626	0.03139
0.43067	0.01719	-0.00809	-0.10705	-0.01823
0.46044	0.01377	-0.00954	-0.12255	-0.08495
0.49000	0.00989	-0.01331	-0.13977	-0.17075

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74	74	74	74	75	77	80	82	84	84	84	83	83	83	83	84	84	84	85	85	85	85	85	85	85	85	85	85	86	86	86	86	86	86	86	86	86	86	86	85	85	81	74
73	73	73	74	76	77	79	82	84	85	85	85	85	85	85	85	85	85	86	86	86	86	86	86	86	86	86	85	87	87	87	87	87	87	88	87	87	87	86	86	85	83	75
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72	71	71	71	71	71	71	71	71	72	72	71	71	69	68	66	64	61	58	54	48	44	49	55	59	62	65	67	69	71	73	75	76	76	79	80	82	83	85	86	87	86	82
72	72	72	72	73	73	74	75	76	77	77	77	77	76	75	73	72	70	69	72	0	0	0	81	76	76	77	78	79	80	81	82	83	84	84	85	86	87	88	88	88	88	84
72	72	72	73	74	75	76	77	79	81	82	83	83	83	84	84	85	87	95	0	0	0	0	0	106	96	93	91	90	89	89	88	88	88	88	88	89	90	90	90	89	89	83
72	72	73	74	75	76	78	80	82	84	86	87	88	89	90	92	94	96	102	0	0	0	0	0	112	106	102	100	98	96	95	94	93	92	92	92	92	92	91	91	90	89	84
72	72	73	74	76	78	80	82	85	86	90	91	92	94	95	97	99	101	104	0	0	0	0	0	114	111	108	106	104	102	100	99	97	96	96	95	94	94	93	92	92	90	84
72	73	73	75	77	79	81	85	88	91	93	94	96	97	99	100	102	106	0	0	0	0	0	0	0	115	112	110	108	107	105	103	101	100	99	98	97	96	95	94	93	91	85
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73	73	74	76	79	82	85	89	92	95	98	99	100	102	103	105	106	109	0	0	0	0	0	0	0	119	117	115	114	113	111	109	108	107	105	104	103	101	99	97	95	93	85
73	73	75	77	80	83	86	90	94	97	99	101	102	104	105	107	108	110	0	0	0	0	0	0	0	120	119	117	116	115	113	112	111	110	108	107	105	103	101	99	97	93	86
73	73	75	77	80	84	87	92	96	99	101	102	104	105	106	108	110	112	0	0	0	0	0	0	0	121	120	119	118	117	116	114	113	112	111	109	107	105	103	101	98	94	86
73	73	75	78	81	84	88	93	97	100	102	103	105	106	107	109	111	112	0	0	0	0	0	0	0	123	122	121	120	119	118	117	115	114	113	111	109	107	105	102	100	94	86
73	73	75	78	81	85	89	93	98	100	102	104	105	107	108	109	111	112	0	0	0	0	0	0	0	125	124	123	121	120	119	118	117	116	115	113	111	109	107	104	101	95	87
73	73	75	78	81	85	89	94	98	101	102	104	105	106	108	109	111	112	0	0	0	0	0	0	0	126	125	124	123	122	121	120	119	118	117	115	113	111	108	106	103	96	87
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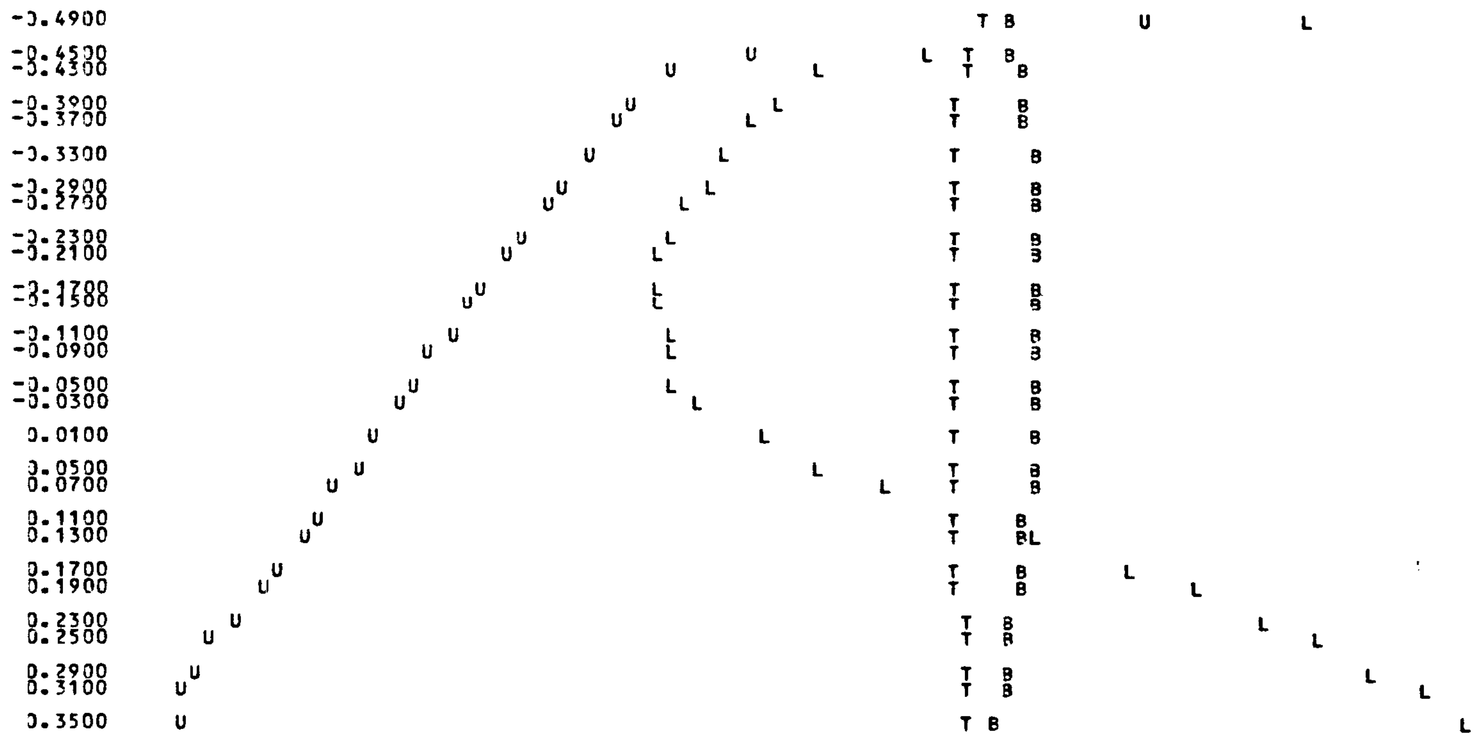
73	73	75	78	81	84	88	93	97	99	101	103	104	105	107	108	110	112	0	0	0	0	0	0	0	129	128	127	126	125	124	123	123	121	120	119	117	114	112	109	105	98	88
73	73	75	77	80	83	87	92	96	98	101	102	103	105	106	108	110	111	0	0	0	0	0	0	0	131	130	129	128	127	126	125	124	123	122	120	118	116	113	110	106	98	89
73	73	75	77	80	83	86	90	94	97	99	100	102	103	104	106	107	109	0	0	0	0	0	0	0	132	131	130	129	128	127	126	125	124	123	122	120	118	115	111	107	99	89
73	73	74	76	79	81	85	88	92	94	96	97	98	100	101	102	104	105	0	0	0	0	0	0	0	133	132	132	131	130	129	128	127	126	125	123	121	119	116	113	108	100	89
73	73	74	76	78	80	83	86	89	92	93	94	95	96	97	98	100	102	0	0	0	0	0	0	0	135	134	133	132	131	130	129	128	127	126	125	123	120	117	114	109	101	90
73	73	74	75	77	79	81	84	87	89	91	92	92	93	94	95	96	99	0	0	0	0	0	0	0	137	135	134	134	133	131	130	129	128	127	126	124	122	118	115	110	101	90
73	73	73	74	76	78	80	82	84	87	88	89	89	90	90	91	91	93	0	0	0	0	0	0	0	138	137	136	135	134	133	132	131	130	128	127	125	123	120	116	111	102	90
72	72	73	74	75	76	78	80	82	84	85	86	86	86	87	87	87	87	88	0	0	0	0	0	0	140	138	137	136	136	134	133	132	131	130	128	126	124	121	117	112	103	91
72	72	72	73	74	75	76	78	80	82	83	83	83	83	83	83	83	83	83	0	0	0	0	0	0	141	140	139	138	137	136	135	133	132	131	129	127	125	122	118	113	103	91
72	72	72	72	73	74	75	76	78	79	80	81	81	80	80	80	79	79	78	0	0	0	0	0	143	142	141	140	139	138	137	136	134	133	132	130	129	126	123	119	113	104	91
72	72	72	72	72	73	74	75	76	77	78	78	78	79	77	77	76	76	75	75	0	0	0	0	145	144	142	141	141	140	138	137	136	134	133	131	130	127	124	120	114	104	91
72	72	71	71	72	72	72	73	74	75	76	76	76	76	75	74	73	73	72	71	0	0	0	0	147	145	144	143	142	141	140	138	137	136	134	133	131	128	125	120	115	105	91
72	71	71	71	71	71	71	72	73	74	74	75	74	74	73	72	71	70	69	68	0	0	0	0	150	147	146	145	143	142	141	140	138	137	135	134	132	129	125	121	115	105	91
72	71	71	70	70	71	71	71	72	72	73	73	73	72	71	70	69	68	67	65	0	0	0	0	151	149	147	146	145	144	142	141	139	138	136	135	133	130	126	122	116	105	91
72	71	70	70	70	70	70	70	71	71	72	72	72	71	70	69	68	66	65	64	62	0	0	151	151	150	149	148	146	145	144	142	141	139	137	136	134	131	127	122	116	106	91

```
72 71 70 70 70 70 70 70 70 71 71 71 71 70 69 68 67 65 64 62 60  0  0148150150150149148147145143142140139137134131127123117106 91
72 71 70 70 69 69 69 69 70 70 71 71 70 70 69 67 66 65 63 61 59  0  0138144146148149149148147145143141140137135132128123117105 90
72 71 70 70 69 69 69 69 70 70 71 71 71 70 69 68 66 65 63 61 58  0  0107111115118123127132137140142141140139136132128123116103 90
72 71 70 69 69 69 69 70 70 71 71 72 71 71 70 69 68 66 65 62 59  0 85 85 86 87 89 92 96 99104108112116119123128130128124117106 89
72 71 70 69 69 69 70 70 71 72 72 73 73 73 72 72 71 70 70 69 69  0 81 82 83 83 84 84 84 85 85 86 88 90 93 97101104106106104100 88
72 71 70 70 70 70 70 71 72 74 75 76 76 77 77 77 77 77 77 77 78 79 79 80 81 81 82 83 83 84 85 85 86 87 87 88 89 90 91 92 93 92 87
72 71 70 70 71 72 73 74 75 77 79 80 80 81 81 81 81 81 81 81 81 81 82 82 83 83 83 84 84 85 85 85 86 86 87 87 88 89 89 89 90 89 84
72 71 71 72 73 74 75 77 79 81 82 83 84 84 84 84 83 83 84 84 84 84 85 85 85 85 86 86 86 86 86 86 87 87 87 88 88 88 88 88 88 87 81
73 72 73 74 75 76 78 80 82 84 85 85 85 85 85 85 85 85 85 86 86 86 86 87 87 87 87 87 87 87 87 87 88 88 88 88 88 88 88 87 87 86 79
74 73 74 75 76 77 80 82 84 85 86 86 86 85 85 86 86 86 86 87 87 87 87 87 87 87 87 87 87 88 88 88 88 88 88 88 88 88 87 87 86 84 77
74 73 74 75 76 78 80 82 84 85 86 86 85 85 85 85 86 86 86 87 87 87 87 87 87 87 87 87 87 87 88 88 88 88 88 89 88 87 87 86 86 83 76
73 73 73 73 73 74 76 77 79 81 82 83 84 84 84 83 83 83 83 83 84 84 85 85 85 85 86 86 86 86 86 86 86 86 86 87 88 88 88 87 87 85 78
0                  WAVE CD =    0.056674   CDCORR =  0.000000
1 NASA AIRFOIL IN NON-UNIFORM FLOW ( NASA ORIGINAL )
```



```
        0.3900      U          U                                                   TB                                L  L
        0.4100                                                                     TB
        0.4500                                         U                           TB                                    L
        0.4700                                                                     TB      U                            L
        0.4900                                                                     TB           U             L
0                 -1.218    -1.016    -0.814    -0.612    -0.410    -0.208    -0.006    0.196    0.398    0.600    0.802
                                                     PRESSURE COEFFICIENT
                                                     CPSTAR =      -0.2078     CLCIR =      0.5357
0                       CL =      0.7798 CD =      0.064441 CMLE =      -0.5295 CDF =      0.007767 CMC4 =      -0.3346
 FINAL EPSS =   1.410000
1
     CPU TIME AFTER ANALYS =  1452.025  SECONDS
```

3. Input Data for Sample Case 2

```
DESIGN OF AN AIRFOIL IN NON-UNIFORM TRANSONIC FLOW
4
4   2  -1
0
0.01  0.0006
0.1  0.1
3  0
0
-0.1  0.004  -0.01  0.001  1.  10.
3
0.001  0.001
16  7  0
 40*0.001
0.785  0.775  0.00811
-0.45
  .8          0.          0.          0.          20950000.
  .246        .15         3.87        .49         2.
  0     0     1     0     0     1     0  0
 13    13     2 3200  6000
  0     0     .004        .44         .5          .1          -.44
  1     2     1     0
  3          .0000025  2000.          50.         1.          5.
 1.4          1.          .1          .125
 0.           3.0         1.4
    .5   10000.
       26     .133
  .52         .45         .4          .35         .3          .25         .2          .15
  .1          .05         0.          -.05        -.1         -.15        -.2         -.25
 -.3          -.35        -.4         -.45        -.5         -.55        -.6         -.65
 -.7          -.75
  .8          .85         .851        .853        .903        .908        .91         .91
  .911        .916        .923        .928        .933        .933        .928        .923
  .923        .911        .91         .91         .908        .903        .853        .851
  .85         .8
 4.86         -.57683     .32533
103
0.          0.          .002        .00925      .005        .01429      .01         .01962
 .02         .02653     .03         .03127      .04         .03471      .05         .03759
 .06         .03991     .07         .04196      .08         .04374      .09         .04537
 .1          .04683     .11         .04814      .12         .04938      .13         .05054
 .14         .05161     .15         .05261      .16         .05352      .17         .05439
 .18         .05521     .19         .05596      .20         .05664      .21         .05726
 .22         .05784     .23         .05839      .24         .05888      .25         .05932
 .26         .05973     .27         .0601       .28         .06043      .29         .06072
 .30         .06098     .31         .0612       .32         .06139      .33         .06152
 .34         .0616      .35         .06166      .36         .06173      .37         .06173
 .38         .06173     .39         .06170      .40         .06163      .41         .0615
 .42         .06136     .43         .06118      .44         .06098      .45         .06074
 .46         .06048     .47         .06019      .48         .05988      .49         .05954
 .50         .05917     .51         .05876      .52         .05834      .53         .0579
 .54         .05741     .55         .05688      .56         .05632      .57         .05573
 .58         .05511     .59         .05447      .60         .05378      .61         .05308
 .62         .05233     .63         .05157      .64         .05077      .65         .04994
 .66         .04906     .67         .04818      .68         .04727      .69         .04631
 .7          .0453      .71         .04426      .72         .04319      .73         .04207
 .74         .04091     .75         .03973      .76         .03850      .77         .03722
 .78         .03589     .79         .03452      .8          .03312      .81         .03168
 .82         .03018     .83         .02866      .84         .02711      .85         .02553
 .86         .02387     .87         .02215      .88         .02040      .89         .01864
 .9          .01682     .91         .01494      .92         .013        .93         .01103
```

.94	.009	.95	.00691	.96	.00476	.97	.00256
.98	.00029	.99	-.00204	1.	-.00444		
0.0	1.0	0.0	0.0				
103							
0.	0.	.002	-.00713	.005	-.01227	.01	-.01774
.02	-.02471	.03	-.02928	.04	-.03297	.05	-.03601
.06	-.03867	.07	-.04101	.08	-.04312	.09	-.04501
.10	-.04675	.11	-.04832	.12	-.04981	.13	-.0512
.14	-.05247	.15	-.05369	.16	-.05479	.17	-.05582
.18	-.05678	.19	-.05767	.20	-.05854	.21	-.05929
.22	-.05998	.23	-.06062	.24	-.06121	.25	-.06174
.26	-.06222	.27	-.06264	.28	-.063	.29	-.06334
.30	-.0636	.31	-.06384	.32	-.06401	.33	-.06417
.34	-.06428	.35	-.06435	.36	-.06439	.37	-.06437
.38	-.06432	.39	-.06423	.40	-.06408	.41	-.06391
.42	-.06363	.43	-.06332	.44	-.06297	.45	-.06252
.46	-.06204	.47	-.0615	.48	-.06090	.49	-.06027
.50	-.05957	.51	-.05879	.52	-.05796	.53	-.05706
.54	-.05608	.55	-.05506	.56	-.05389	.57	-.05269
.58	-.05141	.59	-.05005	.6	-.04859	.61	-.04709
.62	-.0455	.63	-.04388	.64	-.04217	.65	-.04046
.66	-.0387	.67	-.03692	.68	-.03511	.69	-.0333
.7	-.03149	.71	-.02967	.72	-.02786	.73	-.02605
.74	-.02425	.75	-.02246	.76	-.02073	.77	-.01904
.78	-.01739	.79	-.01579	.8	-.01424	.81	-.01275
.82	-.01139	.83	-.01009	.84	-.00889	.85	-.0078
.86	-.00684	.87	-.00599	.88	-.00534	.89	-.00478
.9	-.00436	.91	-.00412	.92	-.00413	.93	-.00434
.94	-.00478	.95	-.00542	.96	-.00627	.97	-.00744
.98	-.00889	.99	-.01058	1.	-.01255		
0.0	-1.0	0.0	0.0				

4. Output for Sample Case 2

```
  FREESTREAM MACH NUMBER PROFILE
     0.8000     0.8000     0.8000     0.8000     0.8000     0.8201     0.8579     0.9079     0.9106     0.9093     0.9185     0.9239     0.9231
     0.9259     0.9294     0.9320     0.9334     0.9337     0.9331     0.9316     0.9297     0.9279     0.9263     0.9247     0.9230     0.9209
     0.9185     0.9161     0.9140     0.9122     0.9109     0.9101     0.9099     0.9102     0.9104     0.9089     0.9078     0.9099     0.8831
     0.8463     0.8555     0.8085     0.8000     0.8000     0.8000     0.8000     0.8000     0.8000     0.8000

  FREESTREAM STAGNATION TEMPERATURE PROFILE
     1.1280     1.1280     1.1280     1.1280     1.1280     1.1345     1.1472     1.1649     1.1659     1.1653     1.1687     1.1707     1.1704
     1.1714     1.1728     1.1737     1.1742     1.1744     1.1741     1.1735     1.1729     1.1722     1.1716     1.1710     1.1704     1.1696
     1.1687     1.1679     1.1671     1.1664     1.1659     1.1657     1.1656     1.1657     1.1658     1.1652     1.1648     1.1655     1.1560
     1.1433     1.1464     1.1307     1.1280     1.1280     1.1280     1.1280     1.1280     1.1280     1.1280

  MACH NUMBER DIVIDED BY SQRT(STAGNATION TEMPERATURE)
     0.7532     0.7532     0.7532     0.7532     0.7532     0.7699     0.8010     0.8412     0.8434     0.8423     0.8496     0.8539     0.8532
     0.8554     0.8582     0.8602     0.8614     0.8615     0.8611     0.8600     0.8585     0.8570     0.8558     0.8546     0.8532     0.8515
     0.8496     0.8478     0.8461     0.8446     0.8436     0.8430     0.8428     0.8431     0.8432     0.8420     0.8411     0.8423     0.8214
     0.7915     0.7990     0.7604     0.7532     0.7532     0.7532     0.7532     0.7532     0.7532     0.7532
1
  DESIGN OF AN AIRFOIL IN NON-UNIFORM TRANSONIC FLOW
0    MACH NO. IS 0.800 ANGLE OF ATTACK IS     0.000 DEGREES
           DIRECT SOLUTION TO      0.50
0    INVISCID ANALYSIS CASE
     WITH VISCOUS INTERACTION
   0.80000    0.00000    0.00000    0.00000 20950000.00000
   0.24600    0.15000    3.87000    0.49000    2.00000
   0     0      1     0     0     1     0     0
  49    49      2  3200  6000
   0     0    0.00400    0.44000    0.10000   -0.44000
   1     2      1     0
         3  0.0000125  2000.00000  50.00000    1.00000    5.00000
   1.40000    1.00000    0.10000    0.12500
   0.00000    3.00000    1.40000

                    X-Y GRID SYSTEM

     1 -0.1565E+02      2 -0.8027E+01      3 -0.3872E+01      4 -0.2276E+01      5 -0.1410E+01      6 -0.9115E+00      7 -0.6471E+00
     8 -0.5317E+00      9 -0.4900E+00     10 -0.4604E+00     11 -0.4307E+00     12 -0.4007E+00     13 -0.3706E+00     14 -0.3403E+00
    15 -0.3098E+00     16 -0.2792E+00     17 -0.2485E+00     18 -0.2177E+00     19 -0.1868E+00     20 -0.1558E+00     21 -0.1247E+00
    22 -0.9357E-01     23 -0.6240E-01     24 -0.3121E-01     25  0.0000E+01     26  0.3121E-01     27  0.6240E-01     28  0.9357E-01
    29  0.1247E+00     30  0.1558E+00     31  0.1868E+00     32  0.2177E+00     33  0.2485E+00     34  0.2792E+00     35  0.3098E+00
    36  0.3403E+00     37  0.3706E+00     38  0.4007E+00     39  0.4307E+00     40  0.4604E+00     41  0.4900E+00     42  0.5317E+00
    43  0.6471E+00     44  0.9115E+00     45  0.1410E+01     46  0.2276E+01     47  0.3872E+01     48  0.8027E+01     49  0.1565E+02
     1 -0.7515E+01      2 -0.3753E+01      3 -0.1869E+01      4 -0.1237E+01      5 -0.9181E+00      6 -0.7247E+00      7 -0.5939E+00
     8 -0.4988E+00      9 -0.4261E+00     10 -0.3682E+00     11 -0.3206E+00     12 -0.2805E+00     13 -0.2460E+00     14 -0.2157E+00
    15 -0.1888E+00     16 -0.1644E+00     17 -0.1420E+00     18 -0.1213E+00     19 -0.1019E+00     20 -0.3351E-01     21 -0.6592E-01
    22 -0.4893E-01     23 -0.3239E-01     24 -0.1612E-01     25 -0.1441E-10     26  0.1612E-01     27  0.3239E-01     28  0.4893E-01
    29  0.6592E-01     30  0.8351E-01     31  0.1019E+00     32  0.1213E+00     33  0.1420E+00     34  0.1644E+00     35  0.1888E+00
    36  0.2157E+00     37  0.2460E+00     38  0.2805E+00     39  0.3206E+00     40  0.3682E+00     41  0.4261E+00     42  0.4988E+00
    43  0.5939E+00     44  0.7247E+00     45  0.9181E+00     46  0.1237E+01     47  0.1869E+01     48  0.3753E+01     49  0.7515E+01
0                          AIRFOIL COORDINATES
      X            YU          YL       UPPER SLOPE LOWER SLOPE
  -0.49000      0.05067    -0.04583     0.88006    -0.89823
  -0.46044      0.08892    -0.08447     0.31220    -0.33716
  -0.43067      0.10736    -0.10492     0.19847    -0.22766
  -0.40072      0.11983    -0.11958     0.14202    -0.16932
```

-0.37058	0.12937	-0.13097	0.11339	-0.13611
-0.34028	0.13705	-0.14015	0.09271	-0.10967
-0.30982	0.14333	-0.14751	0.07386	-0.08816
-0.27923	0.14819	-0.15341	0.05718	-0.06943
-0.24852	0.15202	-0.15792	0.04449	-0.05136
-0.21769	0.15490	-0.16116	0.03276	-0.03566
-0.18677	0.15692	-0.16331	0.01984	-0.02189
-0.15577	0.15794	-0.16447	0.00892	-0.00924
-0.12470	0.15835	-0.16471	0.00119	0.00264
-0.09357	0.15805	-0.16399	-0.00939	0.01757
-0.06240	0.15693	-0.16197	-0.01967	0.03611
-0.03121	0.15511	-0.15859	-0.02806	0.05235
0.00000	0.15267	-0.15401	-0.03603	0.06925
0.03121	0.14956	-0.14792	-0.04607	0.09057
0.06240	0.14563	-0.14012	-0.05639	0.11272
0.09357	0.14096	-0.13058	-0.06564	0.13535
0.12470	0.13554	-0.11927	-0.07554	0.15500
0.15577	0.12937	-0.10668	-0.08415	0.16734
0.18677	0.12251	-0.09335	-0.09487	0.17164
0.21769	0.11468	-0.07987	-0.10718	0.17193
0.24852	0.10595	-0.06648	-0.11897	0.16561
0.27923	0.09623	-0.05394	-0.13175	0.15352
0.30982	0.08557	-0.04247	-0.14261	0.13505
0.34028	0.07421	-0.03292	-0.14938	0.10798
0.37058	0.06277	-0.02568	-0.14201	0.07538
0.40072	0.05269	-0.02144	-0.11626	0.03139
0.43067	0.04438	-0.02094	-0.10705	-0.01823
0.46044	0.03560	-0.02467	-0.12255	-0.08495
0.49000	0.02559	-0.03442	-0.13977	-0.17075

```
*** READ FROM DISK LOUT ***
              0                 0                 1                 1                10
           1709                 0                 0                 0                42
             41                41                42                 0                 0
              9              1710
 BEGINNING EPSS=   1.41000  BEGINNING RDEL=   0.05000
ITER =   12 CIR =    0.26764 DPM =   0.0000014 AT 43 24 NSSP =  571 DELTA =  0.0118 EPSS = 1.40 W = 1.70 UW = 1.00
ITER =   22 CIR =    0.26781 DPM =   0.0000022 AT 43 24 NSSP =  571 DELTA =  0.0118 EPSS = 1.40 W = 1.70 UW = 1.00
ITER =   32 CIR =    0.26786 DPM =   0.0000039 AT 43 24 NSSP =  571 DELTA =  0.0118 EPSS = 1.50 W = 1.70 UW = 1.00
ITER =   40 CIR =    0.26786 DPM =   0.0000010 AT 41 40 NSSP =  571 DELTA =  0.0118 EPSS = 1.60 W = 1.70 UW = 1.00
0BOUNDARY LAYER ANALYSIS FOR REYNOLDS NUMBER OF   0.210E+08
```

X	YUORIG	DU	SLU	YLORIG	DL	SLL
-0.49000	0.01962	0.00000	0.88006	-0.01774	0.00000	-0.89823
-0.46044	0.03457	0.00001	0.31220	-0.03282	0.00001	-0.33716
-0.43067	0.04183	0.00005	0.19847	-0.04086	0.00005	-0.22766
-0.40072	0.04673	0.00013	0.14202	-0.04663	0.00012	-0.16932
-0.37058	0.05048	0.00021	0.11339	-0.05112	0.00021	-0.13611
-0.34028	0.05350	0.00029	0.09271	-0.05476	0.00029	-0.10967
-0.30982	0.05597	0.00037	0.07386	-0.05769	0.00036	-0.08816
-0.27923	0.05788	0.00044	0.05718	-0.06003	0.00042	-0.06943
-0.24852	0.05938	0.00050	0.04449	-0.06181	0.00049	-0.05136
-0.21769	0.06050	0.00057	0.03276	-0.06308	0.00056	-0.03566
-0.18677	0.06127	0.00063	0.01984	-0.06390	0.00063	-0.02189
-0.15577	0.06162	0.00069	0.00892	-0.06431	0.00069	-0.00924
-0.12470	0.06173	0.00075	0.00119	-0.06435	0.00076	0.00264
-0.09357	0.06155	0.00081	-0.00939	-0.06398	0.00083	0.01757
-0.06240	0.06103	0.00087	-0.01967	-0.06305	0.00091	0.03611
-0.03121	0.06023	0.00093	-0.02806	-0.06157	0.00101	0.05235
0.00000	0.05917	0.00093	-0.03603	-0.05957	0.00113	0.06925

ORIGINAL PAGE IS
OF POOR QUALITY

0.03121	0.05784	0.00104	-0.04607	-0.05694	0.00126	0.09067
0.06240	0.05619	0.00109	-0.05639	-0.05360	0.00142	0.11271
0.09357	0.05423	0.00115	-0.06564	-0.04954	0.00163	0.13535
0.12470	0.05193	0.00120	-0.07554	-0.04475	0.00187	0.15500
0.15577	0.04943	0.00125	-0.08415	-0.03945	0.00213	0.16734
0.18577	0.04563	0.00130	-0.09487	-0.03388	0.00241	0.17164
0.21769	0.04344	0.00135	-0.10718	-0.02828	0.00271	0.17194
0.24852	0.03991	0.00140	-0.11897	-0.02272	0.00302	0.16561
0.27923	0.03599	0.00146	-0.13175	-0.01752	0.00334	0.15352
0.30982	0.03171	0.00154	-0.14261	-0.01278	0.00363	0.13505
0.34028	0.02707	0.00172	-0.14938	-0.00886	0.00385	0.10793
0.37058	0.02205	0.00226	-0.14201	-0.00595	0.00397	0.07538
0.40072	0.01569	0.00369	-0.11626	-0.00434	0.00395	0.03138
0.43067	0.01090	0.00625	-0.10705	-0.00436	0.00373	-0.01823
0.46044	0.00467	0.00904	-0.12257	-0.00631	0.00321	-0.08495
0.49000	-0.00204	0.01182	-0.13977	-0.01058	0.00269	-0.17075

*** WRITE ON DISK LOUT ***
CP BY CENTRAL DIFFERENCES

X	CPU	CPL
-0.49000	0.23209	0.47699
-0.46044	-0.35397	-0.09112
-0.43067	-0.48547	-0.25853
-0.40072	-0.53736	-0.31844
-0.37058	-0.56336	-0.35339
-0.34028	-0.59682	-0.39176
-0.30982	-0.63445	-0.42397
-0.27923	-0.66598	-0.45527
-0.24852	-0.69281	-0.48186
-0.21769	-0.72468	-0.49699
-0.18677	-0.75762	-0.50106
-0.15577	-0.78238	-0.49367
-0.12470	-0.80815	-0.48432
-0.09357	-0.83990	-0.48629
-0.06240	-0.86825	-0.48043
-0.03121	-0.89237	-0.43070
0.00000	-0.91869	-0.34433
0.03121	-0.94865	-0.25645
0.06240	-0.97707	-0.16524
0.09357	-1.00465	-0.05410
0.12470	-1.03108	0.07128
0.15577	-1.05707	0.19611
0.18677	-1.08937	0.30735
0.21769	-1.12354	0.40401
0.24852	-1.15767	0.49254
0.27923	-1.19058	0.57163
0.30982	-1.21486	0.64371
0.34028	-1.21767	0.70355
0.37058	-1.16543	0.75167
0.40072	-1.00720	0.78558
0.43067	-0.38351	0.80185
0.46044	0.14142	0.79400
0.49000	0.23967	0.53666
0.53171	0.30634	0.30637
0.64714	0.23419	0.23421
0.91153	0.16385	0.16386
1.40979	0.11528	0.11528
2.27592	0.09474	0.09474
3.37231	0.09758	0.09758
5.02700	0.16376	0.16379

ORIGINAL PAGE IS
OF POOR QUALITY

X	YU	YL	SLU	SLL
-0.49000	0.01962	-0.01774	0.98006	-0.39323
-0.46044	0.03459	-0.03283	0.31220	-0.33716
-0.43067	0.04198	-0.04091	0.19847	-0.22765
-0.40072	0.04686	-0.04676	0.14202	-0.16932
-0.37058	0.05069	-0.05133	0.11339	-0.13611
-0.34028	0.05379	-0.05505	0.09271	-0.10967
-0.30982	0.05634	-0.05804	0.07385	-0.08816
-0.27923	0.05832	-0.06046	0.05718	-0.06943
-0.24852	0.05985	-0.06231	0.04449	-0.05136
-0.21769	0.06107	-0.06364	0.03276	-0.03566
-0.18677	0.06189	-0.06453	0.01984	-0.02189
-0.15577	0.06231	-0.06501	0.00892	-0.00924
-0.12470	0.06249	-0.06511	0.00119	0.00264
-0.09357	0.06236	-0.06481	-0.00939	0.01757
-0.06240	0.06190	-0.06397	-0.01967	0.03611
-0.03121	0.06115	-0.06256	-0.02506	0.05235
0.00000	0.06015	-0.06070	-0.03603	0.06925
0.03121	0.05888	-0.05821	-0.04607	0.09067
0.06240	0.05727	-0.05504	-0.05639	0.11271
0.09357	0.05538	-0.05118	-0.06564	0.13535
0.12470	0.05313	-0.04664	-0.07554	0.15500
0.15577	0.05069	-0.04161	-0.08415	0.16734
0.18677	0.04793	-0.03635	-0.09487	0.17164
0.21769	0.04450	-0.03103	-0.10718	0.17194
0.24852	0.04132	-0.02573	-0.11397	0.16561
0.27923	0.03747	-0.02089	-0.13175	0.15352
0.30982	0.03327	-0.01644	-0.14261	0.13505
0.34028	0.02981	-0.01273	-0.14938	0.10798
0.37058	0.02433	-0.00993	-0.14201	0.07538
0.40072	0.02041	-0.00829	-0.11626	0.03138
0.43067	0.01718	-0.00309	-0.10705	-0.01923
0.46044	0.01377	-0.00954	-0.12257	-0.08495
0.49000	0.00989	-0.01331	-0.13977	-0.17075

1

74	74	74	74	75	77	80	82	84	84	84	83	83	83	83	84	84	84	85	85	85	85	85	85	85	85	85	85	86	86	86	86	86	86	86	86	86	86	86	85	85	81	74
73	73	73	74	76	77	79	82	84	85	85	85	85	85	85	85	85	85	86	86	86	86	86	86	86	86	86	86	87	87	87	87	87	87	88	87	87	87	86	86	85	83	75
72	72	72	73	74	75	77	79	81	83	84	84	84	84	84	84	84	84	84	84	85	85	85	85	86	86	86	86	86	86	86	86	86	86	87	87	87	87	86	86	85	84	76
71	71	70	71	72	73	74	75	77	79	80	81	82	82	82	82	82	82	82	82	82	82	82	82	83	83	83	83	84	84	84	84	84	84	84	85	85	85	85	85	84	83	79
71	70	69	69	70	70	71	71	73	74	75	76	77	78	78	78	78	78	78	78	77	77	77	77	78	78	78	78	79	79	79	80	80	80	81	81	82	83	83	84	83	83	80
71	70	69	69	69	69	69	69	70	71	71	72	72	72	72	71	70	70	69	68	68	68	68	68	69	69	70	71	72	73	74	75	76	77	78	79	80	81	83	84	85	85	81
72	71	71	71	71	71	71	71	71	72	72	71	71	69	68	66	64	61	58	54	48	44	49	55	59	62	65	67	69	71	73	75	76	78	79	80	82	83	85	86	87	86	82
72	72	72	72	73	73	74	75	76	77	77	77	77	76	75	73	72	70	69	72	0	0	0	81	76	76	77	78	79	80	81	82	83	84	84	85	86	87	88	88	88	89	84
72	72	72	73	74	75	76	77	79	81	82	83	83	83	84	84	85	87	95	0	0	0	0	0	106	96	93	91	90	89	89	88	88	88	88	88	89	90	90	90	89	89	83
72	72	73	74	75	76	78	80	82	84	86	87	88	89	90	92	94	96	102	0	0	0	0	0	112	106	102	100	98	96	95	94	93	92	92	92	92	92	91	91	90	89	84
72	72	73	74	76	78	80	82	85	88	90	91	92	94	95	97	99	101	104	0	0	0	0	0	114	111	108	106	104	102	100	99	97	96	96	95	94	94	93	92	92	90	84
72	73	73	75	77	79	81	85	88	91	93	94	96	97	99	100	102	106	0	0	0	0	0	0	0	115	112	110	108	107	105	103	101	100	99	98	97	96	95	94	93	91	85
72	73	74	76	78	80	83	87	90	93	95	97	98	100	101	103	104	107	0	0	0	0	0	0	0	117	115	113	112	110	108	106	105	104	102	101	100	99	97	95	94	92	85
73	73	74	76	79	82	85	89	92	95	98	99	100	102	103	105	106	109	0	0	0	0	0	0	0	119	117	115	114	113	111	109	108	107	105	104	103	101	99	97	95	93	85
73	73	75	77	80	83	86	90	94	97	99	101	102	104	105	107	108	110	0	0	0	0	0	0	0	120	119	117	116	115	113	112	111	110	108	107	105	103	101	99	97	93	86
73	73	75	77	80	84	87	92	96	99	101	102	104	105	106	108	110	112	0	0	0	0	0	0	0	121	120	119	118	117	116	114	113	112	111	109	107	105	103	101	98	94	86
73	73	75	78	81	84	88	93	97	100	102	103	105	106	107	109	111	112	0	0	0	0	0	0	0	123	122	121	120	119	118	117	115	114	113	111	109	107	105	102	100	94	86
73	73	75	78	81	85	89	93	98	100	102	104	105	107	108	109	111	112	0	0	0	0	0	0	0	125	124	123	121	120	119	118	117	116	115	113	111	109	107	104	101	95	87
73	74	75	78	81	85	89	94	98	101	102	104	105	106	108	109	111	112	0	0	0	0	0	0	0	126	125	124	123	122	121	120	119	118	117	115	113	111	108	106	103	96	87
73	73	75	78	81	85	89	93	97	100	102	103	105	106	107	109	110	112	0	0	0	0	0	0	0	127	126	126	125	124	123	122	121	120	119	117	115	113	110	107	104	97	88
73	73	75	78	81	84	88	93	97	99	101	103	104	105	107	108	110	112	0	0	0	0	0	0	0	129	128	127	126	125	124	123	123	121	120	119	117	114	112	109	105	98	88
73	73	75	77	80	83	87	92	96	99	101	102	103	105	106	108	110	111	0	0	0	0	0	0	0	131	130	129	128	127	126	125	124	123	122	120	118	116	113	110	106	98	89
73	73	75	77	80	83	86	90	94	97	99	100	102	103	104	106	107	109	0	0	0	0	0	0	0	132	131	130	129	128	127	126	125	124	123	122	120	118	115	111	107	99	89
73	73	74	76	79	81	85	89	92	94	96	97	98	100	101	102	104	105	0	0	0	0	0	0	0	133	132	132	131	130	129	128	127	126	125	123	121	119	116	113	108	100	89
73	73	74	76	78	80	83	85	89	92	93	94	95	96	97	98	100	102	0	0	0	0	0	0	0	135	134	133	132	131	130	129	128	127	126	125	123	120	117	114	109	101	90

```
73 73 74 75 77 79 81 84 87 89 91 92 92 93 94 95 96 98  0  0  0  0  0  0  01371351341341331311301291281271261241221181151110101 90
73 73 73 74 76 78 80 82 84 87 88 89 89 90 90 91 91 93  0  0  0  0  0  0  01381371361351341331321311301281271251231201161111102 90
72 72 73 74 75 76 78 80 82 84 85 86 86 86 87 87 87 87 98  0  0  0  0  0  01401381371361361341331321311301281261241211171112103 91
72 72 72 73 74 75 76 78 80 82 83 83 83 83 83 83 83 83 83  0  0  0  0  0  01411401391381371361351331321311291271251221131113103 91
72 72 72 72 73 74 75 76 78 79 80 81 81 80 80 80 79 79 78  0  0  0  0  01431421411401391381371361341331321301291261231191113104 91
72 72 72 72 72 73 74 75 76 77 78 78 78 78 77 77 76 76 75 75  0  0  0  01451441421411411401381371361341331311301271241201114104 91
72 72 71 71 72 72 72 73 74 75 76 76 76 76 75 74 73 73 72 71  0  0  0  01471451441431421411401381371361341331311281251201115105 91
72 71 71 71 71 71 71 72 73 74 74 75 74 74 73 72 71 70 69 68  0  0  0  01501471461451431421411401381371351341321291251211115105 91
72 71 71 70 70 71 71 71 72 72 73 73 73 72 71 70 69 68 67 65  0  0  0  01511491471461451441421411391381361351331301261221116105 91
72 71 70 70 70 70 70 70 71 71 72 72 72 71 70 69 68 66 65 64 62  0  01511511501491481461451441421411391371361341311271221116106 91
72 71 70 70 70 70 70 70 70 71 71 71 71 70 69 68 67 65 64 62 60  0  01431501501501491481471451431421401391371341311271231117106 91
72 71 70 70 69 69 69 69 70 70 71 71 70 70 69 67 66 65 63 61 59  0  01381441461481491491481471451431411401371351321281231117105 90
72 71 70 70 69 69 69 69 70 70 71 71 71 70 69 68 66 65 63 61 58  0  01071111151181231271321371401421411401391361321281231116103 90
72 71 70 69 69 69 69 70 70 71 71 72 71 71 70 69 68 66 65 62 59  0 85 85 86 87 39 92 95 99104108112116119123128130128124117106 90
72 71 70 69 69 69 70 70 71 72 72 73 73 73 72 72 71 70 70 69 69  0 81 82 83 83 84 84 84 85 85 86 88 90 93 97101104106106104100 88
72 71 70 70 70 70 70 71 72 74 75 76 76 77 77 77 77 77 77 77 78 79 79 80 81 81 82 83 83 84 85 85 86 87 87 88 89 90 91 92 93 92 87
72 71 70 70 71 72 73 74 75 77 79 80 80 81 81 81 81 81 81 81 81 81 82 82 83 83 83 84 84 85 85 85 86 86 87 87 88 89 89 89 90 89 84
72 71 71 72 73 74 75 77 79 81 82 83 84 84 84 84 83 83 84 84 84 84 85 85 85 85 86 86 86 86 86 86 87 87 87 88 88 88 88 88 88 87 81
73 72 73 74 75 76 78 80 82 84 85 85 85 85 85 85 85 85 85 86 86 86 86 87 87 87 87 87 87 87 87 87 88 88 88 88 88 88 88 87 87 86 79
74 73 74 75 76 77 80 82 84 85 86 86 86 85 85 86 86 86 86 87 87 87 87 87 87 87 87 87 87 88 88 88 88 88 88 88 88 88 87 87 86 84 77
74 73 74 75 76 78 80 82 84 85 86 86 85 85 85 85 86 85 86 87 87 87 87 87 87 87 87 87 87 87 88 88 88 88 88 88 88 87 87 86 86 83 76
73 73 73 73 73 74 76 77 79 81 82 83 84 84 84 83 83 83 83 83 84 84 85 85 85 85 86 86 86 86 86 86 86 86 86 87 88 88 88 87 87 85 78
0                   WAVE CD =    0.056672   CDCORR =   0.000000
1  DESIGN OF AN AIRFOIL IN NON-UNIFORM TRANSONIC FLOW

-0.4900                                                               T B        U         L
-0.4500                                              U            L  T  B
-0.4300                                        U          L          T   B
-0.3900                                      U         L            T    B
-0.3700                                    U         L              T    B
-0.3300                                   U        L                T     B
-0.2900                                 U         L                 T     B
-0.2700                                U        L                   T     B
-0.2300                              U         L                    T     B
-0.2100                             U         L                     T     B
-0.1700                           U           L                     T     B
-0.1500                          U            L                     T     B
-0.1100                         U              L                    T     B
-0.0900                       U                L                    T     B
-0.0500                      U                 L                    T     B
-0.0300                     U                    L                  T     B
 0.0100                   U                           L             T     B
 0.0500                  U                                L         T     B
 0.0700                U                                       L    T     B
 0.1100               U                                             T   B
 0.1300              U                                              T   BL
 0.1700            U                                                T   B       L
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      0.1900          U                                                             T     B              L
      0.2300            U                                                            T   B                    L
      0.2500         U                                                               T   B                        L
      0.2900        U                                                                T   B                            L
      0.3100       U                                                                 T   B                                L
      0.3500       U                                                                 T B                                      L
      0.3900         U                                                                TB                                        L
      0.4100               U                                                          TB                                          L
      0.4500                                          U                               TB                                          L
      0.4700                                                                          TB      U                                 L
      0.4900                                                                          TB          U             L
0              -1.218     -1.016     -0.814     -0.612     -0.410     -0.208     -0.006     0.196     0.398     0.600     0.802
                                                    PRESSURE COEFFICIENT
                                              CPSTAR =     -0.2078       CLCIR =       0.5357
0                           CL =       0.7798 CD =   0.064439 CMLE =    -0.5295 CDF =    0.007767 CMC4 =    -0.3346
 FINAL EPSS =    1.600000
1
    CPU TIME AFTER ANALYS =      30.537  SECONDS
 NII =     9 NIIE =     9 NK =    95
    0.03865    0.02200   -0.02055   -0.00046   -0.00122   -0.00038
   -0.00018   -0.03648   -0.02386    0.01602    0.01032   -0.00437
    0.00181    0.00053
 ITERATION TRACE =      1
1

           * * * * * * * * * * * * * * * * * * * * * * * * * * *
           *                                                   *
           *                    C O N M I N                    *
           *                                                   *
           *               FORTRAN PROGRAM FOR                 *
           *                                                   *
           *        CONSTRAINED FUNCTION MINIMIZATION          *
           *                                                   *
           * * * * * * * * * * * * * * * * * * * * * * * * * * *
1
  DESIGN OF AN AIRFOIL IN NON-UNIFORM TRANSONIC FLOW
0    MACH NO. IS 0.800 ANGLE OF ATTACK IS      0.000 DEGREES
            DIRECT SOLUTION TO       0.50
0    INVISCID ANALYSIS CASE
     WITH VISCOUS INTERACTION
   0.80000    0.00000    0.26786    0.00000 20950000.00000
   0.24600    0.15000    3.87000    0.49000    2.00000
     0     0      1    0      0     0     0     0
    49    49      2 3200  6000
     0     0    0.00400    0.44000    0.10000   -0.44000
     1     2      1    0
           0 0.0000025 2000.00000   50.00000    1.00000    5.00000
   1.40000    1.00000    0.05000    0.06250
   0.00000    1.80000    1.40000
```

```
                                   X-Y GRID SYSTEM

   1 -0.1565E+02    2 -0.8027E+01    3 -0.3872E+01    4 -0.2276E+01    5 -0.1410E+01    6 -0.9115E+00    7 -0.6471E+00
   8 -0.5317E+00    9 -0.4900E+00   10 -0.4604E+00   11 -0.4307E+00   12 -0.4007E+00   13 -0.3706E+00   14 -0.3403E+00
  15 -0.3098E+00   16 -0.2792E+00   17 -0.2485E+00   18 -0.2177E+00   19 -0.1868E+00   20 -0.1558E+00   21 -0.1247E+00
  22 -0.9357E-01   23 -0.6240E-01   24 -0.3121E-01   25  0.0000E+01   26  0.3121E-01   27  0.6240E-01   28  0.9357E-01
  29  0.1247E+00   30  0.1558E+00   31  0.1368E+00   32  0.2177E+00   33  0.2485E+00   34  0.2792E+00   35  0.3098E+00
  36  0.3403E+00   37  0.3706E+00   38  0.4007E+00   39  0.4307E+00   40  0.4604E+00   41  0.4900E+00   42  0.5317E+00
  43  0.6471E+00   44  0.9115E+00   45  0.1410E+01   46  0.2276E+01   47  0.3872E+01   48  0.8027E+01   49  0.1565E+02
   1 -0.7515E+01    2 -0.3753E+01    3 -0.1869E+01    4 -0.1237E+01    5 -0.9181E+00    6 -0.7247E+00    7 -0.5939E+00
   8 -0.4988E+00    9 -0.4261E+00   10 -0.3682E+00   11 -0.3206E+00   12 -0.2805E+00   13 -0.2460E+00   14 -0.2157E+00
  15 -0.1388E+00   16 -0.1644E+00   17 -0.1420E+00   18 -0.1213E+00   19 -0.1019E+00   20 -0.8351E-01   21 -0.6592E-01
  22 -0.4893E-01   23 -0.3239E-01   24 -0.1612E-01   25 -0.1441E-10   26  0.1612E-01   27  0.3239E-01   28  0.4893E-01
  29  0.6592E-01   30  0.8351E-01   31  0.1019E+00   32  0.1213E+00   33  0.1420E+00   34  0.1644E+00   35  0.1888E+00
  36  0.2157E+00   37  0.2460E+00   38  0.2805E+00   39  0.3206E+00   40  0.3682E+00   41  0.4261E+00   42  0.4988E+00
  43  0.5939E+00   44  0.7247E+00   45  0.9181E+00   46  0.1237E+01   47  0.1869E+01   48  0.3753E+01   49  0.7515E+01
0                              AIRFOIL COORDINATES
      X            YU           YL       UPPER SLOPE  LOWER SLOPE
  -0.49000      0.01962     -0.01774      0.83006     -0.89820
  -0.46044      0.03459     -0.03283      0.31192     -0.33833
  -0.43067      0.04170     -0.04084      0.18500     -0.23030
  -0.40072      0.04668     -0.04684      0.14990     -0.17543
  -0.37058      0.05071     -0.05150      0.11779     -0.13604
  -0.34028      0.05392     -0.05513      0.09572     -0.10724
  -0.30982      0.05646     -0.05799      0.07374     -0.08054
  -0.27923      0.05844     -0.06027      0.05480     -0.06723
  -0.24852      0.05995     -0.06208      0.04241     -0.05143
  -0.21769      0.06105     -0.06348      0.03073     -0.03716
  -0.18677      0.06131     -0.06450      0.01702     -0.02896
  -0.15577      0.06225     -0.06512      0.01071     -0.01311
  -0.12470      0.06239     -0.06531     -0.00100      0.00152
  -0.09357      0.06226     -0.06500     -0.00625      0.02071
  -0.06240      0.06184     -0.06416     -0.01850      0.03777
  -0.03121      0.06115     -0.06275     -0.02666      0.05420
   0.00000      0.06018     -0.06072     -0.03450      0.07428
   0.03121      0.05891     -0.05804     -0.04616      0.09521
   0.06240      0.05734     -0.05475     -0.05517      0.11505
   0.09357      0.05547     -0.05037     -0.06369      0.13034
   0.12470      0.05328     -0.04648     -0.07733      0.15131
   0.15577      0.05076     -0.04164     -0.08354      0.16119
   0.18677      0.04792     -0.03650     -0.09681      0.16989
   0.21769      0.04474     -0.03120     -0.10907      0.17298
   0.24852      0.04123     -0.02595     -0.12102      0.16592
   0.27923      0.03739     -0.02096     -0.12953      0.15647
   0.30982      0.03322     -0.01646     -0.14052      0.13789
   0.34028      0.02879     -0.01267     -0.15100      0.10922
   0.37058      0.02436     -0.00935     -0.13872      0.07844
   0.40072      0.02043     -0.00824     -0.11617      0.02497
   0.43067      0.01721     -0.00810     -0.10796     -0.01765
   0.46044      0.01380     -0.00960     -0.12344     -0.08655
   0.49000      0.00988     -0.01332     -0.14151     -0.17154
 BEGINNING EPSS=    1.30000  BEGINNING RDEL=    0.05000
ACCEPTABLE REGION FOR ANALYSIS
AT ITERATION =      1
BEGIN NEWF
AT ITERATION =     10
BEGIN VISACT
AT ITERATION =     10
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STABLE REGION
AT ITERATION =     10
ITER =    10 CIR =   0.26806 DPM =   0.0000271 AT 16 21 NSSP =  570 DELTA =  0.0118 EPSS = 1.80 W = 1.40 UW = 1.00
ITER =    20 CIR =   0.26781 DPM =   0.0000200 AT 22 21 NSSP =  572 DELTA =  0.0118 EPSS = 1.90 W = 1.45 UW = 1.00
ITER =    30 CIR =   0.26768 DPM =   0.0000177 AT 22 21 NSSP =  571 DELTA =  0.0119 EPSS = 1.30 W = 1.50 UW = 1.00
ITER =    40 CIR =   0.26756 DPM =   0.0000155 AT 23 21 NSSP =  572 DELTA =  0.0119 EPSS = 1.70 W = 1.55 UW = 1.00
ITER =    50 CIR =   0.26745 DPM =   0.0000145 AT 34 31 NSSP =  572 DELTA =  0.0119 EPSS = 1.70 W = 1.60 UW = 1.00
ITER =    60 CIR =   0.26737 DPM =   0.0000165 AT 33 31 NSSP =  571 DELTA =  0.0119 EPSS = 1.80 W = 1.65 UW = 1.00
ITER =    70 CIR =   0.26734 DPM =   0.0000149 AT 33 27 NSSP =  569 DELTA =  0.0119 EPSS = 1.90 W = 1.65 UW = 1.00
ITER =    80 CIR =   0.26742 DPM =   0.0000093 AT 32 29 NSSP =  569 DELTA =  0.0118 EPSS = 1.80 W = 1.70 UW = 1.00
ITER =    90 CIR =   0.26752 DPM =   0.0000094 AT 35 28 NSSP =  569 DELTA =  0.0118 EPSS = 1.70 W = 1.70 UW = 1.00
ITER =   100 CIR =   0.26753 DPM =   0.0000090 AT 33 28 NSSP =  569 DELTA =  0.0118 EPSS = 1.70 W = 1.70 UW = 1.00
ITER =   110 CIR =   0.26749 DPM =   0.0000069 AT 33 27 NSSP =  569 DELTA =  0.0118 EPSS = 1.80 W = 1.70 UW = 1.00
ITER =   120 CIR =   0.26743 DPM =   0.0000049 AT 43 24 NSSP =  569 DELTA =  0.0118 EPSS = 1.70 W = 1.70 UW = 1.00
ITER =   130 CIR =   0.26736 DPM =   0.0000058 AT 43 24 NSSP =  569 DELTA =  0.0119 EPSS = 1.60 W = 1.70 UW = 1.00
ITER =   140 CIR =   0.26729 DPM =   0.0000063 AT 43 24 NSSP =  569 DELTA =  0.0119 EPSS = 1.70 W = 1.70 UW = 1.00
ITER =   150 CIR =   0.26721 DPM =   0.0000063 AT 43 24 NSSP =  569 DELTA =  0.0119 EPSS = 1.80 W = 1.70 UW = 1.00
ITER =   160 CIR =   0.26714 DPM =   0.0000062 AT 43 24 NSSP =  569 DELTA =  0.0119 EPSS = 1.80 W = 1.70 UW = 1.00
ITER =   170 CIR =   0.26708 DPM =   0.0000055 AT 43 24 NSSP =  569 DELTA =  0.0119 EPSS = 1.80 W = 1.70 UW = 1.00
ITER =   180 CIR =   0.26711 DPM =   0.0000027 AT 41 26 NSSP =  569 DELTA =  0.0119 EPSS = 1.70 W = 1.70 UW = 1.00
ITER =   185 CIR =   0.26710 DPM =   0.0000022 AT 47 24 NSSP =  569 DELTA =  0.0119 EPSS = 1.60 W = 1.70 UW = 1.00
0BOUNDARY LAYER ANALYSIS FOR REYNOLDS NUMBER OF   0.210E+08
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X	YUORIG	DU	SLU	YLORIG	DL	SLL
-0.49000	0.01962	0.00000	0.88006	-0.01774	0.00000	-0.89820
-0.46044	0.03457	0.00001	0.31192	-0.03282	0.00001	-0.33833
-0.43067	0.04165	0.00005	0.19389	-0.04079	0.00005	-0.22889
-0.40072	0.04655	0.00013	0.14652	-0.04671	0.00012	-0.17491
-0.37058	0.05049	0.00021	0.11965	-0.05129	0.00021	-0.13574
-0.34028	0.05363	0.00029	0.09379	-0.05484	0.00028	-0.10577
-0.30982	0.05609	0.00036	0.07349	-0.05764	0.00036	-0.08349
-0.27923	0.05800	0.00043	0.05643	-0.05985	0.00043	-0.06625
-0.24852	0.05945	0.00050	0.04216	-0.06159	0.00050	-0.05207
-0.21769	0.06049	0.00056	0.02991	-0.06293	0.00057	-0.03923
-0.18677	0.06113	0.00063	0.01913	-0.06385	0.00063	-0.02657
-0.15577	0.06155	0.00069	0.00933	-0.06443	0.00070	-0.01303
-0.12470	0.06164	0.00075	0.00011	-0.06455	0.00076	0.00190
-0.09357	0.06145	0.00081	-0.00381	-0.06417	0.00082	0.01832
-0.06240	0.06099	0.00087	-0.01767	-0.06325	0.00090	0.03597
-0.03121	0.06023	0.00093	-0.02666	-0.06174	0.00100	0.05473
0.00000	0.05920	0.00098	-0.03583	-0.05959	0.00113	0.07469
0.03121	0.05787	0.00104	-0.04537	-0.05678	0.00129	0.09544
0.06240	0.05625	0.00109	-0.05516	-0.05331	0.00145	0.11560
0.09357	0.05432	0.00114	-0.06525	-0.04923	0.00164	0.13384
0.12470	0.05207	0.00120	-0.07564	-0.04459	0.00186	0.14946
0.15577	0.04951	0.00125	-0.08670	-0.03949	0.00211	0.16168
0.18677	0.04661	0.00130	-0.09717	-0.03405	0.00239	0.16939
0.21769	0.04338	0.00135	-0.10825	-0.02845	0.00270	0.17144
0.24852	0.03982	0.00141	-0.11947	-0.02289	0.00303	0.16699
0.27923	0.03591	0.00146	-0.13080	-0.01759	0.00336	0.15557
0.30982	0.03166	0.00154	-0.14155	-0.01280	0.00366	0.13694
0.34028	0.02706	0.00172	-0.14798	-0.00880	0.00388	0.11050
0.37058	0.02208	0.00226	-0.14139	-0.00586	0.00399	0.07551
0.40072	0.01671	0.00370	-0.11627	-0.00429	0.00394	0.03064
0.43067	0.01093	0.00626	-0.10610	-0.00436	0.00371	-0.02025
0.46044	0.00469	0.00909	-0.12209	-0.00637	0.00319	-0.08574
0.49000	-0.00205	0.01189	-0.14043	-0.01055	0.00268	-0.16623

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*** WRITE ON DISK LOUT ***
CP BY CENTRAL DIFFERENCES
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ORIGINAL PAGE IS
OF POOR QUALITY

X	CPU	CPL
-0.49000	0.23627	0.48182
-0.46044	-0.36943	-0.08443
-0.43067	-0.48686	-0.23397
-0.40072	-0.51152	-0.31239
-0.37053	-0.54585	-0.38591
-0.34028	-0.59414	-0.43655
-0.30982	-0.63525	-0.46281
-0.27923	-0.67133	-0.47130
-0.24852	-0.70252	-0.46764
-0.21769	-0.73058	-0.45782
-0.18677	-0.75699	-0.44884
-0.15577	-0.78292	-0.44803
-0.12470	-0.80887	-0.45909
-0.09357	-0.83502	-0.47951
-0.06240	-0.86167	-0.50231
-0.03121	-0.88930	-0.50922
0.00000	-0.91724	-0.40768
0.03121	-0.94504	-0.24310
0.06240	-0.97417	-0.12754
0.09357	-1.00450	-0.02465
0.12470	-1.03505	0.08136
0.15577	-1.06523	0.18673
0.18677	-1.09605	0.29142
0.21769	-1.12696	0.39130
0.24852	-1.15830	0.48340
0.27923	-1.18863	0.56714
0.30982	-1.21257	0.64192
0.34029	-1.21527	0.70454
0.37053	-1.16516	0.75465
0.40072	-1.00411	0.78686
0.43067	-0.37808	0.79985
0.46044	0.14223	0.78581
0.49000	0.24142	0.53505
0.53171	0.30823	0.30832
0.64714	0.23435	0.23437
0.91153	0.16372	0.16373
1.40979	0.11524	0.11524
2.27592	0.09483	0.09483
3.57231	0.09774	0.09774
8.02700	0.16411	0.16414

X	YU	YL	SLU	SLL
-0.49000	0.01962	-0.01774	0.88006	-0.89820
-0.46044	0.03459	-0.03283	0.31192	-0.33833
-0.43067	0.04170	-0.04084	0.19339	-0.22889
-0.40072	0.04669	-0.04684	0.14652	-0.17491
-0.37058	0.05071	-0.05149	0.11965	-0.13574
-0.34028	0.05392	-0.05513	0.09379	-0.10577
-0.30982	0.05646	-0.05799	0.07349	-0.08349
-0.27923	0.05644	-0.06027	0.05643	-0.06625
-0.24852	0.05995	-0.06209	0.04216	-0.05207
-0.21769	0.06105	-0.06349	0.02991	-0.03928
-0.18677	0.06181	-0.06451	0.01913	-0.02657
-0.15577	0.06225	-0.06513	0.00933	-0.01303
-0.12470	0.06239	-0.06531	0.00011	0.00190
-0.09357	0.06226	-0.06499	-0.00881	0.01832
-0.06240	0.06184	-0.06415	-0.01767	0.03597
-0.03121	0.06115	-0.06274	-0.02666	0.05473
0.00000	0.06018	-0.06072	-0.03583	0.07469
0.03121	0.05691	-0.05807	-0.04537	0.09544

ORIGINAL PAGE IS
OF POOR QUALITY

0.06240	0.05734	-0.05477	-0.05516	0.11560
0.09357	0.05547	-0.05085	-0.06525	0.13384
0.12470	0.05323	-0.04646	-0.07564	0.14946
0.15577	0.05076	-0.04162	-0.08630	0.16163
0.18677	0.04792	-0.03647	-0.09717	0.16939
0.21769	0.04474	-0.03119	-0.10825	0.17144
0.24852	0.04123	-0.02596	-0.11947	0.16699
0.27923	0.03739	-0.02098	-0.13080	0.15557
0.30982	0.03322	-0.01649	-0.14155	0.13694
0.34028	0.02879	-0.01270	-0.14798	0.11050
0.37058	0.02436	-0.00985	-0.14139	0.07551
0.40072	0.02043	-0.00823	-0.11627	0.03064
0.43067	0.01722	-0.00907	-0.10610	-0.02025
0.46044	0.01384	-0.00958	-0.12209	-0.08574
0.49000	0.00996	-0.01330	-0.14043	-0.16623

1

74	74	74	74	75	77	80	82	84	84	84	83	83	83	83	84	84	84	85	85	85	85	85	85	85	85	85	85	86	86	86	86	86	86	86	86	86	86	86	85	85	81	74
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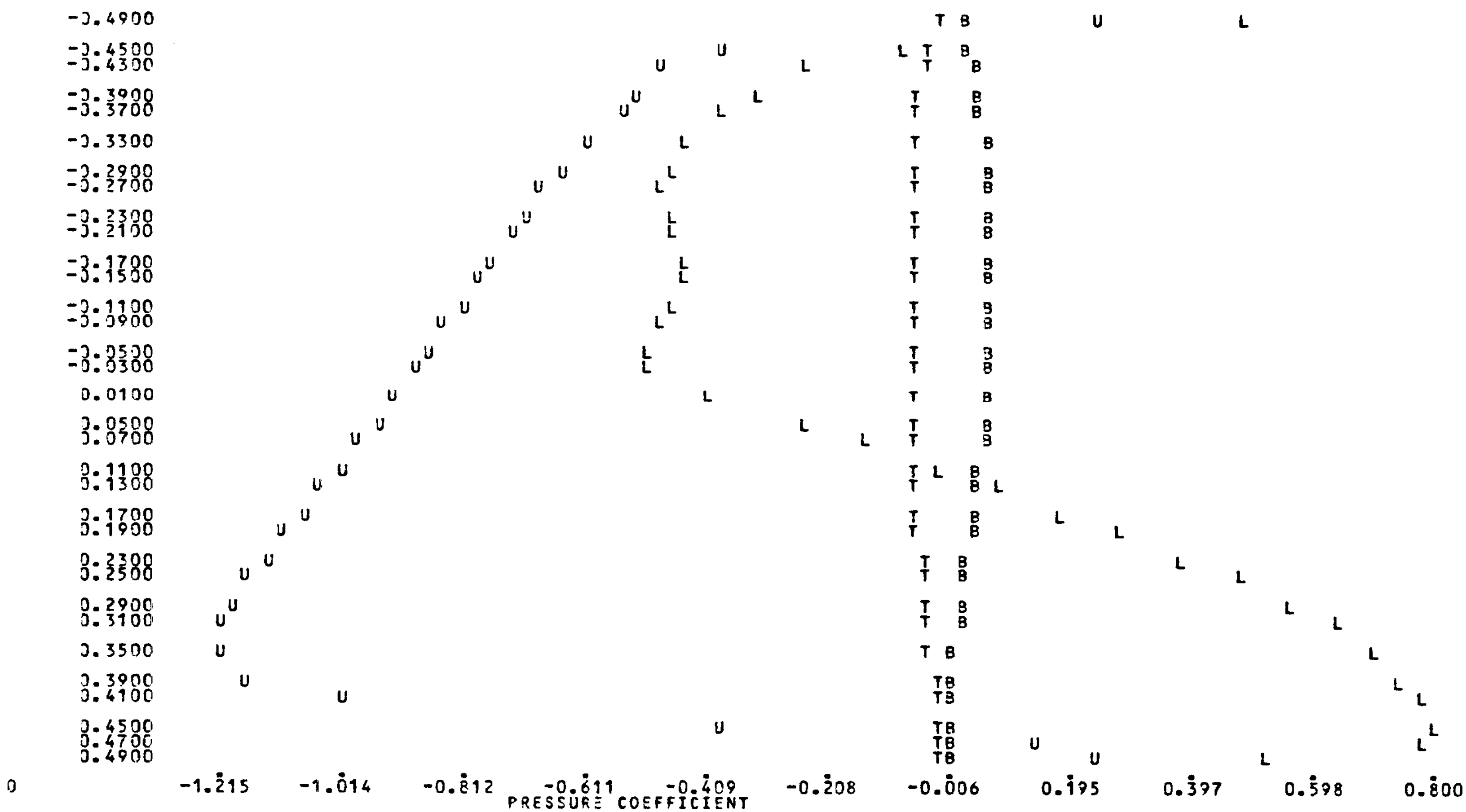
72	71	71	71	71	71	72	72	73	74	74	75	74	74	73	72	71	70	69	68	0	0	0	0	150	147	146	145	144	143	141	140	138	137	135	134	132	129	125	121	115	105	91
72	71	71	71	71	71	71	71	72	73	73	73	73	72	71	70	69	68	67	65	0	0	0	0	151	149	147	146	145	144	143	141	140	138	136	135	133	130	126	122	116	105	91
72	71	70	70	70	70	70	70	71	72	72	72	72	71	70	69	68	66	65	64	62	0	0	151	151	150	149	148	147	145	144	142	141	139	138	136	133	131	127	122	116	106	91
72	71	70	70	70	70	70	70	70	71	71	71	71	70	69	68	67	65	64	62	60	0	0	143	150	150	150	149	148	147	145	144	142	140	139	137	134	131	127	123	117	106	91
72	71	70	70	70	69	69	70	70	71	71	71	71	70	69	67	66	65	63	61	59	0	0	138	144	146	148	149	149	148	147	145	143	141	140	138	135	132	127	123	117	105	90
72	71	70	70	69	69	69	70	70	71	71	71	71	70	69	68	66	65	63	61	58	0	0	107	111	114	118	122	127	132	137	140	141	142	141	139	136	132	128	123	116	103	90
72	71	70	69	69	69	69	70	70	71	71	72	71	71	70	69	68	66	65	63	59	0	85	85	86	87	89	92	95	99	104	108	112	116	119	123	128	130	128	124	117	106	89
72	71	70	69	69	69	70	70	71	72	72	73	73	73	72	72	71	70	70	69	69	0	81	82	82	83	84	84	84	85	85	86	88	90	93	97	101	104	106	105	104	100	88
72	71	70	70	70	70	70	71	72	74	75	76	76	77	77	77	77	77	77	77	78	76	79	80	81	81	82	83	83	84	85	85	86	86	87	88	89	90	91	92	92	92	87
72	71	70	70	71	72	73	74	76	77	79	80	81	81	81	81	81	81	81	81	81	81	82	82	83	83	83	84	84	85	85	85	85	86	87	87	88	89	89	89	90	89	84
72	71	71	72	73	74	75	77	79	81	83	83	84	84	84	84	83	83	84	84	84	84	85	85	85	85	86	86	86	86	86	86	87	87	87	88	88	88	88	88	88	87	91
73	72	73	74	75	76	78	80	82	84	85	85	85	85	85	85	85	85	85	86	86	86	86	87	87	87	87	87	87	87	87	87	88	88	88	88	88	88	88	87	87	86	79

```
  74 73 74 75 76 77 80 82 84 85 86 86 86 85 85 86 86 86 86 87 87 87 87 87 87 87 87 87 87 88 88 88 88 88 88 88 88 88 87 87 86 84 77
  74 73 74 75 76 73 80 82 84 85 86 86 85 85 85 85 86 86 86 87 87 87 87 87 87 87 87 87 87 88 88 88 88 88 88 88 88 87 87 86 86 83 76
0 73 73 73 73 73 74 76 77 79 81 82 83 84 84 84 83 83 83 83 83 84 84 85 85 85 85 86 86 86 86 86 86 86 86 86 87 88 88 88 87 87 85 78
              WAVE CD =   0.056932  CDCORR =  0.000000
1  DESIGN OF AN AIRFOIL IN NON-UNIFORM TRANSONIC FLOW
```



```
                                                    CPSTAR =      -0.2077     CLCIR =        0.5342
0                         CL =       0.7777 CD =     0.064680 CMLE =     -0.5283 CDF =     0.007748 CMC4 =     -0.3339
 FINAL EPSS =    1.600000
1
    CPU TIME AFTER ANALYS =    167.554   SECONDS
 ITERATION TRACE =        2


    CONSTRAINED FUNCTION MINIMIZATION

    CONTROL PARAMETERS

    IPRINT   NDV    ITMAX     NCON     NSIDE   ICNDIR    NSCAL    NFDG
       4      14       2         3        0       15       -1       0

    LINOBJ   ITRM      N1        N2       N3      N4       N5
       0       3       16         3        4      16       32

          CT              CTMIN             CTL             CTLMIN
    -0.10000E+00      0.40000E-02     -0.10000E-01      0.10000E-02

         THETA             PHI            DELFUN           DABFUN
     0.10000E+01      0.50000E+01      0.10000E-02      0.10000E-02

          FDCH            FDCHM           ALPHAX           ABOBJ1
     0.10000E-01      0.60000E-03      0.10000E+00      0.10000E+00

    SCALING VECTOR (SCAL)
     0.1000E-02   0.1000E-02   0.1000E-02   0.1000E-02   0.1000E-02   0.1000E-02   0.1000E-02
     0.1000E-02   0.1000E-02   0.1000E-02   0.1000E-02   0.1000E-02   0.1000E-02   0.1000E-02

    ALL CONSTRAINTS ARE NON-LINEAR

    INITIAL FUNCTION INFORMATION

    OBJ =   -0.120247E+02

    DECISION VARIABLES (X-VECTOR)
 ( 1)     0.386482E-01  0.220016E-01 -0.205530E-01 -0.460442E-03 -0.121920E-02 -0.379729E-03 -0.178393E-03
 ( 8)    -0.364758E-01 -0.238565E-01  0.160175E-01  0.103161E-01 -0.436569E-02  0.180577E-02  0.529685E-03

    CONSTRAINT VALUES (G-VECTOR)
 ( 1)    -0.923598E-01 -0.354808E-01 -0.173855E-02



    BEGIN ITERATION NUMBER     1

    CT =  -0.10000E+00     CTL =  -0.10000E-01      PHI =    0.50000E+01
 BEGINNING EPSS=    1.50000  BEGINNING RDEL=    0.05000
 ACCEPTABLE REGION FOR ANALYSIS
 AT ITERATION =       1
 BEGIN NEWF
```

```
AT ITERATION =     10
BEGIN VISACT
AT ITERATION =     10
STABLE REGION
AT ITERATION =     10
ITER =  185 CIR =     0.26689 DPM =    0.0000023 AT  5 48 NSSP =  567 DELTA =  0.0119 EPSS = 1.60 W = 1.70 UW = 1.00
0                  WAVE CD =   0.056504  CDCORR =  0.000000
                                         PRESSURE COEFFICIENT

                                         CPSTAR =     -0.2077     CLCIR =       0.5338
0                      CL =       0.7762 CD =    0.064254 CMLE =    -0.5281 CDF =    0.007750 CMC4 =     -0.3340
 FINAL EPSS =   1.600000
1
  BEGINNING EPSS=   1.60000  BEGINNING RDEL=   0.05000
 ACCEPTABLE REGION FOR ANALYSIS
 AT ITERATION =      1
 BEGIN NEWF
 AT ITERATION =     10
 BEGIN VISACT
 AT ITERATION =     10
 STABLE REGION
 AT ITERATION =     10
 ITER =  147 CIR =     0.26824 DPM =    0.0000025 AT 37  2 NSSP =  568 DELTA =  0.0119 EPSS = 1.40 W = 1.70 UW = 1.00
0                  WAVE CD =   0.057316  CDCORR =  0.000000
                                         PRESSURE COEFFICIENT

                                         CPSTAR =     -0.2077     CLCIR =       0.5365
0                      CL =       0.7802 CD =    0.065056 CMLE =    -0.5296 CDF =    0.007739 CMC4 =     -0.3345
 FINAL EPSS =   1.400000
1
  BEGINNING EPSS=   1.40000  BEGINNING RDEL=   0.05000
 ACCEPTABLE REGION FOR ANALYSIS
 AT ITERATION =      1
 BEGIN NEWF
 AT ITERATION =     10
 BEGIN VISACT
 AT ITERATION =     10
 STABLE REGION
 AT ITERATION =     10
 ITER =  161 CIR =     0.26730 DPM =    0.0000025 AT 41 44 NSSP =  568 DELTA =  0.0116 EPSS = 1.40 W = 1.70 UW = 1.00
0                  WAVE CD =   0.055523  CDCORR =  0.000000
                                         PRESSURE COEFFICIENT
                                         CPSTAR =     -0.2077     CLCIR =       0.5346
0                      CL =       0.7785 CD =    0.063264 CMLE =    -0.5267 CDF =    0.007741 CMC4 =     -0.3321
 FINAL EPSS =   1.400000
1
  BEGINNING EPSS=   1.40000  BEGINNING RDEL=   0.05000
 ACCEPTABLE REGION FOR ANALYSIS
 AT ITERATION =      1
 BEGIN NEWF
 AT ITERATION =     10
 BEGIN VISACT
 AT ITERATION =     10
 STABLE REGION
 AT ITERATION =     10
 ITER =  249 CIR =     0.26911 DPM =    0.0000025 AT 41 26 NSSP =  570 DELTA =  0.0123 EPSS = 1.40 W = 1.70 UW = 1.00
0                  WAVE CD =   0.056243  CDCORR =  0.000000
                                         PRESSURE COEFFICIENT
```

```
                                          CPSTAR =       -0.2080     CLCIR =       0.5382
0                   CL =       0.7831 CD =   0.064130 CMLE =     -0.5304 CDF =    0.007887 CMC4 =     -0.3346
 FINAL EPSS =   1.400000
1
  BEGINNING EPSS=   1.40000  BEGINNING RDEL=   0.05000
 ACCEPTABLE REGION FOR ANALYSIS
 AT ITERATION =       1
 BEGIN NEWF
 AT ITERATION =     10
 BEGIN VISACT
 AT ITERATION =     10
 STABLE REGION
 AT ITERATION =     10
 ITER =   245 CIR =     0.26708 DPM =   0.0000023 AT 43 24 NSSP =  569 DELTA =  0.0105 EPSS = 1.40 W = 1.70 UW = 1.00
0                   WAVE CD =   0.056735  CDCORR =  0.000000
                                          PRESSURE COEFFICIENT
                                          CPSTAR =       -0.2077     CLCIR =       0.5342
0                   CL =       0.7773 CD =   0.064526 CMLE =     -0.5273 CDF =    0.007790 CMC4 =     -0.3330
 FINAL EPSS =   1.400000
1
  BEGINNING EPSS=   1.40000  BEGINNING RDEL=   0.05000
 ACCEPTABLE REGION FOR ANALYSIS
 AT ITERATION =       1
 BEGIN NEWF
 AT ITERATION =     10
 BEGIN VISACT
 AT ITERATION =     10
 STABLE REGION
 AT ITERATION =     10
 ITER =   437 CIR =     0.27051 DPM =   0.0000025 AT 31 22 NSSP =  570 DELTA =  0.0124 EPSS = 1.40 W = 1.70 UW = 1.00
0                   WAVE CD =   0.056753  CDCORR =  0.000000
                                          PRESSURE COEFFICIENT
                                          CPSTAR =       -0.2082     CLCIR =       0.5410
0                   CL =       0.7871 CD =   0.064974 CMLE =     -0.5352 CDF =    0.008221 CMC4 =     -0.3384
 FINAL EPSS =   1.400000
1
  BEGINNING EPSS=   1.40000  BEGINNING RDEL=   0.05000
 ACCEPTABLE REGION FOR ANALYSIS
 AT ITERATION =       1
 BEGIN NEWF
 AT ITERATION =     10
 BEGIN VISACT
 AT ITERATION =     10
 STABLE REGION
 AT ITERATION =     10
 ITER =   579 CIR =     0.26392 DPM =   0.0000025 AT 27 21 NSSP =  573 DELTA =  0.0103 EPSS = 1.40 W = 1.70 UW = 1.00
0                   WAVE CD =   0.057246  CDCORR =  0.000000
                                          PRESSURE COEFFICIENT
                                          CPSTAR =       -0.2073     CLCIR =       0.5278
0                   CL =       0.7688 CD =   0.065184 CMLE =     -0.5238 CDF =    0.007939 CMC4 =     -0.3316
 FINAL EPSS =   1.400000
1
  BEGINNING EPSS=   1.40000  BEGINNING RDEL=   0.05000
 ACCEPTABLE REGION FOR ANALYSIS
 AT ITERATION =       1
 BEGIN NEWF
 AT ITERATION =     10
```

```
 BEGIN VISACT
 AT ITERATION =     10
 STABLE REGION
 AT ITERATION =     10
0ITER =  239 CIR =    0.26558 DPM =    0.0000025 AT 22 21 NSSP =  572 DELTA =  0.0117 EPSS = 1.42 W = 1.70 UW = 1.00
                       WAVE CD =   0.056920  CDCORR =  0.000000
                                             PRESSURE COEFFICIENT

                                             CPSTAR =     -0.2074     CLCIR =      0.5332
0                      CL =      0.7760 CD =    0.064660 CMLE =    -0.5280 CDF =    0.007740 CMC4 =    -0.3340
 FINAL EPSS =   1.420000
1
  BEGINNING EPSS=   1.42000  BEGINNING RDEL=   0.05000
 ACCEPTABLE REGION FOR ANALYSIS
 AT ITERATION =      1
 BEGIN NEWF
 AT ITERATION =     10
 BEGIN VISACT
 AT ITERATION =     10
 STABLE REGION
 AT ITERATION =     10
0ITER =  525 CIR =    0.26834 DPM =    0.0000024 AT 32 11 NSSP =  569 DELTA =  0.0119 EPSS = 1.40 W = 1.70 UW = 1.00
                       WAVE CD =   0.057393  CDCORR =  0.000000
                                             PRESSURE COEFFICIENT

                                             CPSTAR =     -0.2079     CLCIR =      0.5367
0                      CL =      0.7804 CD =    0.065164 CMLE =    -0.5291 CDF =    0.007771 CMC4 =    -0.3340
 FINAL EPSS =   1.400000
1
  BEGINNING EPSS=   1.40000  BEGINNING RDEL=   0.05000
 ACCEPTABLE REGION FOR ANALYSIS
 AT ITERATION =      1
 BEGIN NEWF
 AT ITERATION =     10
 BEGIN VISACT
 AT ITERATION =     10
 STABLE REGION
 AT ITERATION =     10
0ITER =  690 CIR =    0.26338 DPM =    0.0000025 AT 28 21 NSSP =  576 DELTA =  0.0118 EPSS = 1.41 W = 1.70 UW = 1.00
                       WAVE CD =   0.056875  CDCORR =  0.000000
                                             PRESSURE COEFFICIENT

                                             CPSTAR =     -0.2070     CLCIR =      0.5268
0                      CL =      0.7671 CD =    0.064579 CMLE =    -0.5219 CDF =    0.007705 CMC4 =    -0.3301
 FINAL EPSS =   1.410000
1
  BEGINNING EPSS=   1.41000  BEGINNING RDEL=   0.05000
 ACCEPTABLE REGION FOR ANALYSIS
 AT ITERATION =      1
 BEGIN NEWF
 AT ITERATION =     10
 BEGIN VISACT
 AT ITERATION =     10
 STABLE REGION
 AT ITERATION =     10
0ITER =  748 CIR =    0.27024 DPM =    0.0000025 AT 24 21 NSSP =  572 DELTA =  0.0120 EPSS = 1.40 W = 1.70 UW = 1.00
                       WAVE CD =   0.057925  CDCORR =  0.000000
                                             PRESSURE COEFFICIENT

                                             CPSTAR =     -0.2084     CLCIR =      0.5405
```

```
0                                  CL =      0.7856 CD =    0.065761 CMLE =     -0.5338 CDF =    0.007836 CMC4 =     -0.3374
 FINAL EPSS =    1.400000
1
  BEGINNING EPSS=    1.40000  BEGINNING RDEL=    0.05000
 ACCEPTABLE REGION FOR ANALYSIS
 AT ITERATION =        1
 BEGIN NEWF
 AT ITERATION =      10
 BEGIN VISACT
 AT ITERATION =      10
 STABLE REGION
 AT ITERATION =      10
 ITER =   857 CIR =     0.26122 DPM =    0.0000025 AT 37 46 NSSP =   570 DELTA =   0.0117 EPSS = 1.41 W = 1.70 UW = 1.00
0                       WAVE CD =    0.056714   CDCORR =  0.000000
                                                PRESSURE COEFFICIENT

                                                CPSTAR =     -0.2074     CLCIR =       0.5224
0                                  CL =      0.7612 CD =    0.064351 CMLE =     -0.5197 CDF =    0.007638 CMC4 =     -0.3294
 FINAL EPSS =    1.410000
1
  BEGINNING EPSS=    1.41000  BEGINNING RDEL=    0.05000
 ACCEPTABLE REGION FOR ANALYSIS
 AT ITERATION =        1
 BEGIN NEWF
 AT ITERATION =      10
 BEGIN VISACT
 AT ITERATION =      10
 STABLE REGION
 AT ITERATION =      10
 ITER =   944 CIR =     0.27273 DPM =    0.0000025 AT 21 21 NSSP =   570 DELTA =   0.0121 EPSS = 1.40 W = 1.70 UW = 1.00
0                       WAVE CD =    0.058361   CDCORR =  0.000000
                                                PRESSURE COEFFICIENT

                                                CPSTAR =     -0.2095     CLCIR =       0.5455
0                                  CL =      0.7917 CD =    0.066337 CMLE =     -0.5374 CDF =    0.007976 CMC4 =     -0.3395
 FINAL EPSS =    1.400000
1
  BEGINNING EPSS=    1.40000  BEGINNING RDEL=    0.05000
 ACCEPTABLE REGION FOR ANALYSIS
 AT ITERATION =        1
 BEGIN NEWF
 AT ITERATION =      10
 BEGIN VISACT
 AT ITERATION =      10
 STABLE REGION
 AT ITERATION =      10
 ITER =   960 CIR =     0.26907 DPM =    0.0000024 AT 43 24 NSSP =   572 DELTA =   0.0117 EPSS = 1.41 W = 1.70 UW = 1.00
0                       WAVE CD =    0.057980   CDCORR =  0.000000
                                                PRESSURE COEFFICIENT

                                                CPSTAR =     -0.2075     CLCIR =       0.5201
0                                  CL =      0.7587 CD =    0.065665 CMLE =     -0.5149 CDF =    0.007684 CMC4 =     -0.3252
 FINAL EPSS =    1.410000
1
      THERE ARE     3 ACTIVE CONSTRAINTS
      CONSTRAINT NUMBERS ARE
           1    2    3

      THERE ARE     0 VIOLATED CONSTRAINTS
```

```
      GRADIENT OF OBJ
( 1)    -0.917705E-01  0.526060E-01 -0.468433E+00 -0.309698E+00 -0.355475E-01 -0.149546E+00  0.383417E+00
( 8)     0.394264E-01  0.802904E-01  0.244513E+00  0.129451E+00  0.327369E+00  0.151006E+00  0.784955E+00

      GRADIENTS OF ACTIVE AND VIOLATED CONSTRAINTS
      CONSTRAINT NUMBER     1
( 1)    -0.335986E-01  0.524393E-01  0.161985E-01  0.112785E+00 -0.100796E-01  0.199061E+00 -0.189585E+00
( 8)    -0.375614E-01  0.570366E-01 -0.226718E+00  0.167544E+00 -0.352172E+00  0.295423E+00 -0.405127E+00

      CONSTRAINT NUMBER     2
( 1)     0.340321E-01 -0.531159E-01 -0.164075E-01 -0.114240E+00  0.102096E-01 -0.201629E+00  0.192031E+00
( 8)     0.380461E-01 -0.577726E-01  0.229644E+00 -0.169706E+00  0.356716E+00 -0.299235E+00  0.410354E+00

      CONSTRAINT NUMBER     3
( 1)     0.123305E+00 -0.123305E+00  0.123305E+00 -0.123305E+00  0.123305E+00 -0.123305E+00  0.123305E+00
( 8)    -0.123305E+00  0.123305E+00 -0.123305E+00  0.123305E+00 -0.123305E+00  0.123305E+00 -0.123305E+00

      PUSH-OFF FACTORS, (THETA(I), I=1,NAC)
( 1)     0.583733E-02  0.416273E+00  0.965531E+00

      CONSTRAINT PARAMETER, BETA =  -0.76398E-09

      CALCULATED ALPHA =   0.00000E+01

      OBJ =  -0.120247E+02     NO CHANGE ON OBJ

      DECISION VARIABLES (X-VECTOR)
( 1)     0.386482E-01  0.220016E-01 -0.205530E-01 -0.460442E-03 -0.121920E-02 -0.379729E-03 -0.178393E-03
( 8)    -0.364758E-01 -0.238565E-01  0.160175E-01  0.103161E-01 -0.436569E-02  0.180577E-02  0.529685E-03

      CONSTRAINT VALUES (G-VECTOR)
( 1)    -0.923598E-01 -0.354808E-01 -0.173855E-02


      BEGIN ITERATION NUMBER    2

      CT =  -0.34200E-01     CTL =  -0.46416E-02     PHI =   0.50000E+01

      THERE ARE    1 ACTIVE CONSTRAINTS
      CONSTRAINT NUMBERS ARE
          3

      THERE ARE    0 VIOLATED CONSTRAINTS

      GRADIENT OF OBJ
( 1)    -0.917705E-01  0.526060E-01 -0.468433E+00 -0.309698E+00 -0.355475E-01 -0.149546E+00  0.383417E+00
( 8)     0.394264E-01  0.802904E-01  0.244513E+00  0.129451E+00  0.327369E+00  0.151006E+00  0.784955E+00

      GRADIENTS OF ACTIVE AND VIOLATED CONSTRAINTS
      CONSTRAINT NUMBER     3
( 1)     0.267261E+00 -0.267261E+00  0.267261E+00 -0.267261E+00  0.267261E+00 -0.267261E+00  0.267261E+00
( 8)    -0.267261E+00  0.267261E+00 -0.267261E+00  0.267261E+00 -0.267261E+00  0.267261E+00 -0.267261E+00

      PUSH-OFF FACTORS, (THETA(I), I=1,NAC)
( 1)     0.900913E+00
```

```
    CONSTRAINT PARAMETER, BETA =   0.14060E+01

    SEARCH DIRECTION (S-VECTOR)
( 1)   -0.291291E+00  0.349702E+00  0.270475E+00  0.890054E+00 -0.375144E+00  0.651198E+00 -0.100000E+01
( 8)    0.369359E+00 -0.547903E+00  0.634864E-01 -0.621227E+00 -0.600872E-01 -0.653376E+00 -0.742546E+00

    ONE-DIMENSIONAL SEARCH
    INITIAL SLOPE = -0.1620E+01  PROPOSED ALPHA =  0.3920E-02



* * * CONSTRAINED ONE-DIMENSIONAL SEARCH INFORMATION * * *

    PROPOSED DESIGN
    ALPHA = 0.89196E-02
    X-VECTOR
  0.3365E-01  0.2200E-01 -0.2055E-01 -0.4525E-03 -0.1223E-02 -0.3739E-03 -0.1873E-03 -0.3647E-01
 -0.2386E-01  0.1602E-01  0.1031E-01 -0.4366E-02  0.1300E-02  0.5231E-03
 BEGINNING EPSS=   1.41000  BEGINNING RDEL=   0.05000
 ACCEPTABLE REGION FOR ANALYSIS
 AT ITERATION =      1
 BEGIN NEWF
 AT ITERATION =     10
 BEGIN VISACT
 AT ITERATION =     10
 STABLE REGION
 AT ITERATION =     10
 ITER =  748 CIR =     0.26639 DPM =   0.0000025 AT 43 24 NSSP =  572 DELTA =  0.0119 EPSS = 1.42 W = 1.70 UW = 1.00
0                 WAVE CD =   0.056760  CDCORR =  0.000000
                                        PRESSURE COEFFICIENT

                                        CPSTAR =    -0.2036     CLCIR =     0.5328
0                 CL =      0.7754 CD =   0.064526 CMLE =    -0.5273 COF =   0.007766 CMC4 =     -0.3335
 FINAL EPSS =   1.420000
1
  ITERATION TRACE =    17

    OBJ = -0.12017E+02

    CONSTRAINT VALUES
 -0.1219E+00 -0.5544E-02 -0.6951E-02

    TWO-POINT INTERPOLATION

    PROPOSED DESIGN
    ALPHA = 0.29639E-02
    X-VECTOR
  0.3365E-01  0.2200E-01 -0.2055E-01 -0.4578E-03 -0.1220E-02 -0.3778E-03 -0.1814E-03 -0.3647E-01
 -0.2386E-01  0.1602E-01  0.1031E-01 -0.4366E-02  0.1304E-02  0.5275E-03
 BEGINNING EPSS=   1.42000  BEGINNING RDEL=   0.05000
 ACCEPTABLE REGION FOR ANALYSIS
 AT ITERATION =      1
 BEGIN NEWF
 AT ITERATION =     10
 BEGIN VISACT
```

```
AT ITERATION =     10
STABLE REGION
AT ITERATION =     10
ITER =    35 CIR =     0.26638 DPM =    0.0000018 AT 39 13 NSSP =  572 DELTA =  0.0119 EPSS = 1.52 W = 1.55 UW = 1.00
0                     WAVE CD =    0.056793  CDCORR =  0.000000
                                            PRESSURE COEFFICIENT

                                            CPSTAR =     -0.2086     CLCIR =       0.5328
0                    CL =       0.7754 CD =   0.064558 CMLE =    -0.5273 CDF =   0.007765 CMC4 =     -0.3334
 FINAL EPSS =   1.520000
1
  ITERATION TRACE =     18

     OBJ = -0.12011E+02

     CONSTRAINT VALUES
 -0.1224E+00 -0.5067E-02 -0.3471E-02

     THREE-POINT INTERPOLATION

     PROPOSED DESIGN
     ALPHA = 0.27933E-03
     X-VECTOR
   0.3865E-01  0.2200E-01 -0.2055E-01 -0.4602E-03 -0.1219E-02 -0.3795E-03 -0.1787E-03 -0.3648E-01
  -0.2386E-01  0.1602E-01  0.1032E-01 -0.4366E-02  0.1806E-02  0.5295E-03
  BEGINNING EPSS=    1.52000  BEGINNING RDEL=    0.05000
 ACCEPTABLE REGION FOR ANALYSIS
 AT ITERATION =      1
 ITER =    10 CIR =     0.26635 DPM =    0.0000025 AT 41 26 NSSP =  572 DELTA =  0.0119 EPSS = 1.52 W = 1.40 UW = 1.00
0                     WAVE CD =    0.056797  CDCORR =  0.000000
                                            PRESSURE COEFFICIENT

                                            CPSTAR =     -0.2086     CLCIR =       0.5327
0                    CL =       0.7753 CD =   0.064555 CMLE =    -0.5272 CDF =   0.007758 CMC4 =     -0.3334
 FINAL EPSS =   1.520000
1
  ITERATION TRACE =     19

     OBJ = -0.12010E+02

     CONSTRAINT VALUES
 -0.1234E+00 -0.4042E-02 -0.1902E-02

     * * * END OF ONE-DIMENSIONAL SEARCH

     CALCULATED ALPHA =  -0.26645E-13

     OBJ =   -0.120247E+02      NO CHANGE ON OBJ

     DECISION VARIABLES (X-VECTOR)
 ( 1)     0.386482E-01  0.220016E-01 -0.205530E-01 -0.460442E-03 -0.121920E-02 -0.379729E-03 -0.178393E-03
 ( 8)    -0.364758E-01 -0.238365E-01  0.160175E-01  0.103161E-01 -0.436569E-02  0.180577E-02  0.529685E-03

     CONSTRAINT VALUES (G-VECTOR)
 ( 1)    -0.923595E-01 -0.354808E-01 -0.173855E-02
1
```

```
FINAL OPTIMIZATION INFORMATION

 OBJ =  -0.120247E+02

   DECISION VARIABLES (X-VECTOR)
( 1)    0.336482E-01  0.220016E-01 -0.205530E-01 -0.460442E-03 -0.121920E-02 -0.379729E-03 -0.178393E-03
( 8)   -0.364758E-01 -0.238565E-01  0.160175E-01  0.103161E-01 -0.436569E-02  0.180577E-02  0.529685E-03

   CONSTRAINT VALUES (G-VECTOR)
( 1)   -0.923598E-01 -0.354303E-01 -0.173855E-02

   THERE ARE     1 ACTIVE CONSTRAINTS
   CONSTRAINT NUMBERS ARE
       3

   THERE ARE     0 VIOLATED CONSTRAINTS

   TERMINATION CRITERION
        ITER EQUALS ITMAX

   NUMBER OF ITERATIONS =     2

   OBJECTIVE FUNCTION WAS EVALUATED          18  TIMES

   CONSTRAINT FUNCTIONS WERE EVALUATED       13  TIMES

        THE FINAL AIRFOIL SHAPE
```

1

X/C	YU/C	X/C	YL/C
0.000000	0.000000	0.000000	0.000000
0.002000	0.009250	0.002000	-0.007130
0.005000	0.014290	0.005000	-0.012270
0.010000	0.019620	0.010000	-0.017740
0.020000	0.026530	0.020000	-0.024710
0.030000	0.031270	0.030000	-0.029280
0.040000	0.034710	0.040000	-0.032970
0.050000	0.037590	0.050000	-0.036010
0.060000	0.039365	0.060000	-0.038594
0.070000	0.041770	0.070000	-0.040938
0.080000	0.043521	0.080000	-0.043081
0.090000	0.045145	0.090000	-0.045041
0.100000	0.046653	0.100000	-0.046934
0.110000	0.048059	0.110000	-0.048476
0.120000	0.049357	0.120000	-0.049980
0.130000	0.050560	0.130000	-0.051361
0.140000	0.051673	0.140000	-0.052630
0.150000	0.052702	0.150000	-0.053797
0.160000	0.053653	0.160000	-0.054871
0.170000	0.054530	0.170000	-0.055862
0.180000	0.055338	0.180000	-0.056777
0.190000	0.056082	0.190000	-0.057622
0.200000	0.056764	0.200000	-0.058404
0.210000	0.057390	0.210000	-0.059128
0.220000	0.057962	0.220000	-0.059797
0.230000	0.058484	0.230000	-0.060416
0.240000	0.058958	0.240000	-0.060988
0.250000	0.059386	0.250000	-0.061514
0.260000	0.059772	0.260000	-0.061995
0.270000	0.060116	0.270000	-0.062439

0.280000	0.060422	0.280000	-0.062840
0.290000	0.060591	0.290000	-0.063200
0.300000	0.060924	0.300000	-0.063519
0.310000	0.061123	0.310000	-0.063797
0.320000	0.061288	0.320000	-0.064034
0.330000	0.061421	0.330000	-0.064229
0.340000	0.061523	0.340000	-0.064380
0.350000	0.061594	0.350000	-0.064496
0.360000	0.061636	0.360000	-0.064547
0.370000	0.061648	0.370000	-0.064559
0.380000	0.061630	0.380000	-0.064521
0.390000	0.061585	0.390000	-0.064433
0.400000	0.061510	0.400000	-0.064291
0.410000	0.061407	0.410000	-0.064094
0.420000	0.061276	0.420000	-0.063841
0.430000	0.061116	0.430000	-0.063529
0.440000	0.060929	0.440000	-0.063157
0.450000	0.060712	0.450000	-0.062724
0.460000	0.060467	0.460000	-0.062227
0.470000	0.060193	0.470000	-0.061666
0.480000	0.059890	0.480000	-0.061039
0.490000	0.059558	0.490000	-0.060346
0.500000	0.059196	0.500000	-0.059586
0.510000	0.058805	0.510000	-0.058758
0.520000	0.058383	0.520000	-0.057862
0.530000	0.057930	0.530000	-0.056898
0.540000	0.057447	0.540000	-0.055867
0.550000	0.056933	0.550000	-0.054769
0.560000	0.056387	0.560000	-0.053604
0.570000	0.055810	0.570000	-0.052375
0.580000	0.055200	0.580000	-0.051082
0.590000	0.054558	0.590000	-0.049728
0.600000	0.053884	0.600000	-0.048314
0.610000	0.053176	0.610000	-0.046844
0.620000	0.052435	0.620000	-0.045320
0.630000	0.051660	0.630000	-0.043745
0.640000	0.050851	0.640000	-0.042123
0.650000	0.050008	0.650000	-0.040459
0.660000	0.049131	0.660000	-0.038756
0.670000	0.048219	0.670000	-0.037020
0.680000	0.047272	0.680000	-0.035256
0.690000	0.046289	0.690000	-0.033465
0.700000	0.045271	0.700000	-0.031664
0.710000	0.044217	0.710000	-0.029849
0.720000	0.043127	0.720000	-0.028031
0.730000	0.042001	0.730000	-0.026216
0.740000	0.040838	0.740000	-0.024411
0.750000	0.039637	0.750000	-0.022625
0.760000	0.038400	0.760000	-0.020865
0.770000	0.037124	0.770000	-0.019141
0.780000	0.035811	0.780000	-0.017460
0.790000	0.034459	0.790000	-0.015833
0.800000	0.033067	0.800000	-0.014269
0.810000	0.031636	0.810000	-0.012774
0.820000	0.030165	0.820000	-0.011363
0.830000	0.028652	0.830000	-0.010045
0.840000	0.027098	0.840000	-0.008829
0.850000	0.025502	0.850000	-0.007727
0.860000	0.023862	0.860000	-0.006749
0.870000	0.022177	0.870000	-0.005907

```
  0.880000      0.020447      0.880000     -0.005211
  0.890000      0.018570      0.890000     -0.004674
  0.900000      0.016345      0.900000     -0.004307
  0.910000      0.014970      0.910000     -0.004122
  0.920000      0.013344      0.920000     -0.004130
  0.930000      0.011065      0.930000     -0.004342
  0.940000      0.009030      0.940000     -0.004772
  0.950000      0.006939      0.950000     -0.005430
  0.960000      0.004788      0.960000     -0.006329
  0.970000      0.002575      0.970000     -0.007480
  0.980000      0.000293      0.980000     -0.008894
  0.990000     -0.002048      0.990000     -0.010584
  1.000000     -0.004464      1.000000     -0.012560
1
 DESIGN OF AN AIRFOIL IN NON-UNIFORM TRANSONIC FLOW
0   MACH NO. IS 0.800 ANGLE OF ATTACK IS      0.000 DEGREES
           DIRECT SOLUTION TO         0.50
0   INVISCID ANALYSIS CASE
    WITH VISCOUS INTERACTION
  0.80000    0.00000    0.26635    0.00000 20950000.00000
  0.24600    0.15000    3.87000    0.49000    2.00000
   0    0     1    0     0    0     0    0
  49   49     2 3200  6000
   0    0    0.00400    0.44000    0.10000   -0.44000
   1    2     1    0
        0 0.0000025 2000.00000   50.00000    1.00000    5.00000
  1.40000    1.00000    0.05000    0.06250
  0.00000    1.52000    1.40000

                        X-Y GRID SYSTEM

   1 -0.1565E+02   2 -0.8027E+01   3 -0.3872E+01   4 -0.2276E+01   5 -0.1410E+01   6 -0.9115E+00   7 -0.6471E+00
   8 -0.5317E+00   9 -0.4900E+00  10 -0.4604E+00  11 -0.4307E+00  12 -0.4007E+00  13 -0.3706E+00  14 -0.3403E+00
  15 -0.3098E+00  16 -0.2792E+00  17 -0.2485E+00  18 -0.2177E+00  19 -0.1868E+00  20 -0.1558E+00  21 -0.1247E+00
  22 -0.9357E-01  23 -0.6240E-01  24 -0.3121E-01  25  0.0000E+01  26  0.3121E-01  27  0.6240E-01  28  0.9357E-01
  29  0.1247E+00  30  0.1558E+00  31  0.1868E+00  32  0.2177E+00  33  0.2485E+00  34  0.2792E+00  35  0.3098E+00
  36  0.3403E+00  37  0.3706E+00  38  0.4007E+00  39  0.4307E+00  40  0.4604E+00  41  0.4900E+00  42  0.5317E+00
  43  0.6471E+00  44  0.9115E+00  45  0.1410E+01  46  0.2276E+01  47  0.3872E+01  48  0.8027E+01  49  0.1565E+02
   1 -0.7515E+01   2 -0.3753E+01   3 -0.1869E+01   4 -0.1237E+01   5 -0.9181E+00   6 -0.7247E+00   7 -0.5939E+00
   8 -0.4988E+00   9 -0.4261E+00  10 -0.3682E+00  11 -0.3206E+00  12 -0.2805E+00  13 -0.2460E+00  14 -0.2157E+00
  15 -0.1888E+00  16 -0.1644E+00  17 -0.1420E+00  18 -0.1213E+00  19 -0.1019E+00  20 -0.8351E-01  21 -0.6592E-01
  22 -0.4893E-01  23 -0.3239E-01  24 -0.1612E-01  25 -0.1441E-10  26  0.1612E-01  27  0.3239E-01  28  0.4893E-01
  29  0.6592E-01  30  0.8351E-01  31  0.1019E+00  32  0.1213E+00  33  0.1420E+00  34  0.1644E+00  35  0.1888E+00
  36  0.2157E+00  37  0.2460E+00  38  0.2805E+00  39  0.3206E+00  40  0.3682E+00  41  0.4261E+00  42  0.4988E+00
  43  0.5939E+00  44  0.7247E+00  45  0.9181E+00  46  0.1237E+01  47  0.1869E+01  48  0.3753E+01  49  0.7515E+01
0                         AIRFOIL COORDINATES
      X           YU           YL      UPPER SLOPE  LOWER SLOPE
  -0.49000     0.01962     -0.01774     0.88006     -0.89820
  -0.46044     0.03459     -0.03283     0.31192     -0.33833
  -0.43067     0.04170     -0.04084     0.19390     -0.22891
  -0.40072     0.04668     -0.04684     0.14652     -0.17489
  -0.37058     0.05071     -0.05149     0.11964     -0.13574
  -0.34028     0.05392     -0.05513     0.09378     -0.10578
  -0.30982     0.05646     -0.05799     0.07348     -0.08354
  -0.27923     0.05844     -0.06028     0.05643     -0.06632
  -0.24852     0.05995     -0.06209     0.04217     -0.05214
  -0.21769     0.06105     -0.06350     0.02992     -0.03931
  -0.18677     0.06181     -0.06452     0.01914     -0.02654
```

-0.15577	0.06225	-0.06513	0.00933	-0.01294
-0.12470	0.06239	-0.06531	0.00012	0.00203
-0.09357	0.06226	-0.06499	-0.00831	0.01847
-0.06240	0.06184	-0.06414	-0.01768	0.03606
-0.03121	0.06115	-0.06273	-0.02667	0.05455
0.00000	0.06018	-0.06073	-0.03538	0.07428
0.03121	0.05891	-0.05808	-0.04537	0.09514
0.06240	0.05734	-0.05479	-0.05518	0.11564
0.09357	0.05547	-0.05039	-0.06527	0.13414
0.12470	0.05327	-0.04647	-0.07565	0.14980
0.15577	0.05076	-0.04161	-0.08628	0.16187
0.18677	0.04792	-0.03647	-0.09715	0.16936
0.21769	0.04474	-0.03118	-0.10823	0.17129
0.24852	0.04123	-0.02596	-0.11947	0.16680
0.27923	0.03739	-0.02099	-0.13081	0.15538
0.30982	0.03322	-0.01650	-0.14157	0.13678
0.34028	0.02879	-0.01272	-0.14799	0.11045
0.37058	0.02436	-0.00937	-0.14139	0.07567
0.40072	0.02043	-0.00824	-0.11626	0.03102
0.43067	0.01722	-0.00807	-0.10600	-0.02000
0.46044	0.01334	-0.00957	-0.12193	-0.08567
0.49000	0.00997	-0.01329	-0.14027	-0.15607

BEGINNING EPSS= 1.52000 BEGINNING RDEL= 0.05000
ACCEPTABLE REGION FOR ANALYSIS
AT ITERATION = 1
ITER = 9 CIR = 0.26633 DFM = 0.0000024 AT 41 26 NSSP = 572 DELTA = 0.0119 EPSS = 1.52 W = 1.40 UW = 1.00
0BOUNDARY LAYER ANALYSIS FOR REYNOLDS NUMBER OF 0.210E+05

X	YUORIG	DU	SLU	YLORIG	DL	SLL
-0.49000	0.01962	0.00000	0.58006	-0.01774	0.00000	-0.89820
-0.46044	0.03457	0.00001	0.31192	-0.03282	0.00001	-0.33833
-0.43067	0.04165	0.00005	0.19389	-0.04079	0.00005	-0.22888
-0.40072	0.04655	0.00013	0.14652	-0.04671	0.00012	-0.17489
-0.37058	0.05049	0.00021	0.11964	-0.05128	0.00021	-0.13573
-0.34028	0.05363	0.00029	0.09373	-0.05484	0.00028	-0.10578
-0.30982	0.05609	0.00036	0.07348	-0.05764	0.00036	-0.08354
-0.27923	0.05900	0.00043	0.05643	-0.05985	0.00043	-0.06632
-0.24852	0.05945	0.00050	0.04217	-0.06159	0.00050	-0.05214
-0.21769	0.06049	0.00056	0.02992	-0.06293	0.00057	-0.03931
-0.18677	0.06118	0.00063	0.01914	-0.06383	0.00064	-0.02654
-0.15577	0.06156	0.00069	0.00933	-0.06443	0.00070	-0.01294
-0.12470	0.06164	0.00075	0.00012	-0.06455	0.00076	0.00203
-0.09357	0.06145	0.00081	-0.00831	-0.06417	0.00082	0.01847
-0.06240	0.06095	0.00087	-0.01766	-0.06325	0.00089	0.03606
-0.03121	0.06023	0.00092	-0.02667	-0.06174	0.00099	0.05455
0.00000	0.05920	0.00098	-0.03588	-0.05959	0.00114	0.07429
0.03121	0.05787	0.00104	-0.04537	-0.05678	0.00130	0.09514
0.06240	0.05625	0.00109	-0.05513	-0.05331	0.00147	0.11564
0.09357	0.05432	0.00114	-0.06527	-0.04923	0.00165	0.13414
0.12470	0.05207	0.00120	-0.07565	-0.04459	0.00186	0.14980
0.15577	0.04951	0.00125	-0.08628	-0.03948	0.00210	0.16187
0.18677	0.04661	0.00130	-0.09715	-0.03405	0.00238	0.16936
0.21769	0.04338	0.00135	-0.10823	-0.02845	0.00269	0.17129
0.24852	0.03982	0.00140	-0.11947	-0.02289	0.00303	0.16680
0.27923	0.03591	0.00146	-0.13081	-0.01759	0.00336	0.15538
0.30982	0.03166	0.00154	-0.14157	-0.01280	0.00367	0.13678
0.34028	0.02706	0.00172	-0.14799	-0.00880	0.00390	0.11045
0.37058	0.02203	0.00226	-0.14140	-0.00586	0.00400	0.07567
0.40072	0.01671	0.00369	-0.11642	-0.00429	0.00395	0.03102
0.43067	0.01093	0.00624	-0.10663	-0.00435	0.00370	-0.02000

ORIGINAL PAGE IS
OF POOR QUALITY

0.46044	0.00469	0.00904	-0.12283	-0.00637	0.00318	-0.08567
0.49000	-0.00205	0.01184	-0.14105	-0.01058	0.00267	-0.16607

*** WRITE ON DISK LOUT ***

CP BY CENTRAL DIFFERENCES

X	CPU	CPL
-0.49000	0.23394	0.47882
-0.46044	-0.37158	-0.08731
-0.43067	-0.48792	-0.23651
-0.40072	-0.51136	-0.31473
-0.37058	-0.54469	-0.38308
-0.34028	-0.59281	-0.43820
-0.30982	-0.63389	-0.46407
-0.27923	-0.67011	-0.47254
-0.24852	-0.70145	-0.46942
-0.21769	-0.72960	-0.46078
-0.18677	-0.75601	-0.45331
-0.15577	-0.78187	-0.45365
-0.12470	-0.80775	-0.46508
-0.09357	-0.83387	-0.48476
-0.06240	-0.86056	-0.50518
-0.03121	-0.88317	-0.50720
0.00000	-0.91589	-0.40342
0.03121	-0.94360	-0.24363
0.06240	-0.97279	-0.13072
0.09357	-1.00312	-0.02565
0.12470	-1.03379	0.08144
0.15577	-1.06432	0.18659
0.18677	-1.09536	0.29087
0.21769	-1.12654	0.38989
0.24952	-1.15833	0.48101
0.27923	-1.18897	0.56429
0.30982	-1.21311	0.63886
0.34028	-1.21606	0.70125
0.37058	-1.16631	0.75123
0.40072	-1.00563	0.78392
0.43067	-0.37832	0.79749
0.46044	0.14201	0.78349
0.49000	0.23926	0.53260
0.53171	0.30655	0.30664
0.64714	0.23475	0.23477
0.91153	0.16671	0.16672
1.40979	0.11872	0.11872
2.27592	0.09717	0.09717
3.87231	0.09915	0.09915
8.02700	0.16594	0.16597

X	YU	YL	SLU	SLL
-0.49000	0.01962	-0.01774	0.88006	-0.99820
-0.46044	0.03459	-0.03283	0.31192	-0.33833
-0.43067	0.04170	-0.04084	0.19389	-0.22885
-0.40072	0.04668	-0.04684	0.14652	-0.17489
-0.37058	0.05071	-0.05149	0.11964	-0.13573
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-0.30982	0.05646	-0.05799	0.07348	-0.08354
-0.27923	0.05844	-0.06028	0.05643	-0.06632
-0.24852	0.05995	-0.06209	0.04217	-0.05214
-0.21769	0.06105	-0.06350	0.02992	-0.03931
-0.18677	0.06161	-0.06452	0.01914	-0.02654
-0.15577	0.06225	-0.06513	0.00933	-0.01294
-0.12470	0.06239	-0.06531	0.00012	0.00203

-0.09357	0.06226	-0.06499	-0.00881	0.01847
-0.06240	0.06184	-0.06414	-0.01768	0.03606
-0.03121	0.06115	-0.06273	-0.02667	0.05455
0.00000	0.06018	-0.06073	-0.03588	0.07429
0.03121	0.05891	-0.05808	-0.04537	0.09514
0.06240	0.05734	-0.05479	-0.05513	0.11564
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0.12470	0.05327	-0.04647	-0.07565	0.14980
0.15577	0.05076	-0.04161	-0.08623	0.16187
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0.34028	0.02879	-0.01272	-0.14799	0.11045
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0.49000	0.00990	-0.01329	-0.14105	-0.16507

1

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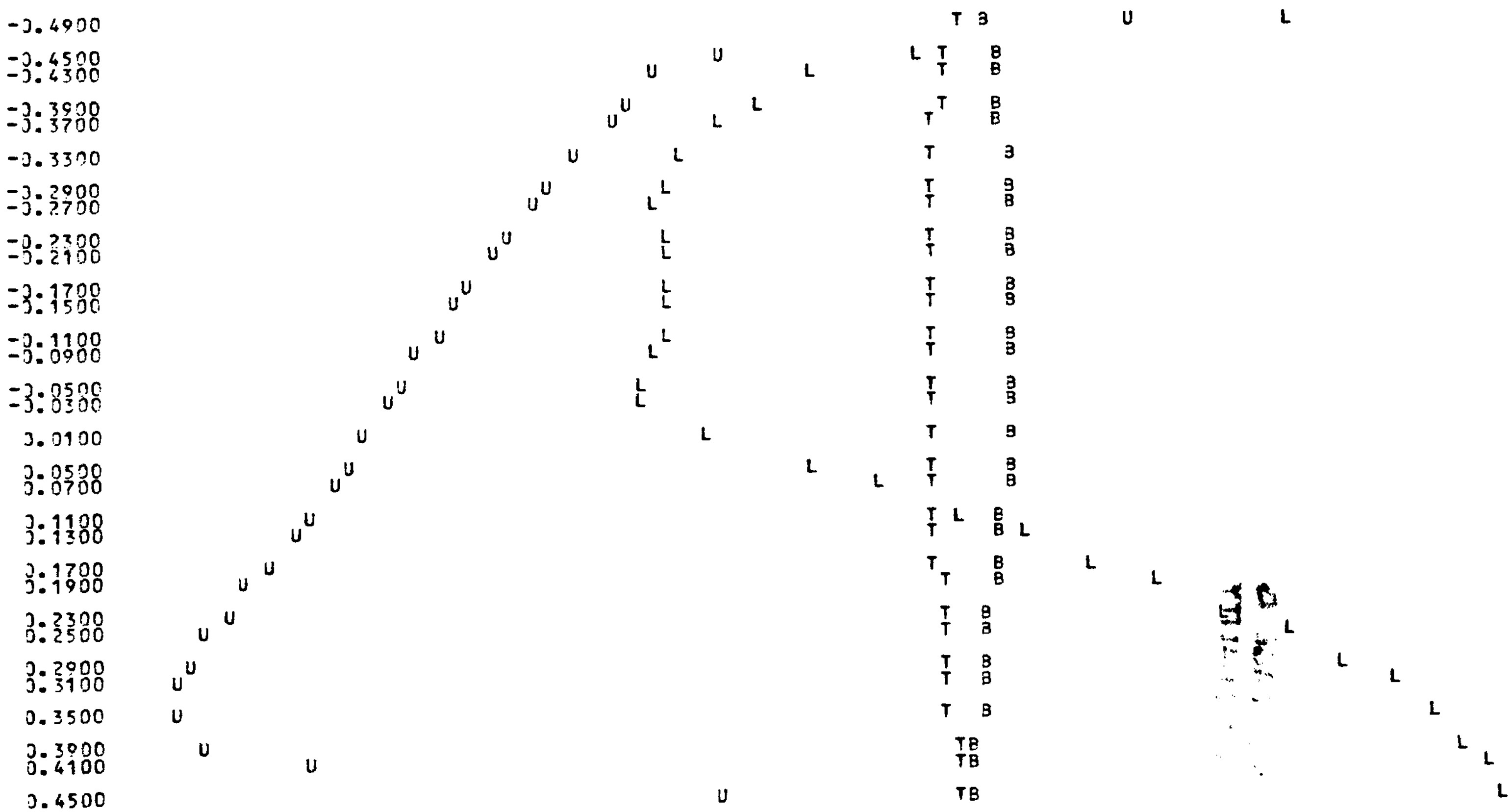
WAVE CD = 0.056786 CDCORR = 0.000000

1 DESIGN OF AN AIRFOIL IN NON-UNIFORM TRANSONIC FLOW



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    0.4700                                                                            TB      U                                L
    0.4900                                                                            T B         U              L
0            -1.216    -1.015    -0.813    -0.612    -0.411    -0.209    -0.008    0.193    0.395    0.596    0.797
                                                  PRESSURE COEFFICIENT

                                                  CPSTAR =     -0.2086     CLCIR =      0.5327
0                      CL =      0.7753 CD =      0.064545 CMLE =     -0.5272 CDF =      0.007759 CMC4 =    -0.3334
 FINAL EPSS =   1.520000
1
     CPU TIME AFTER ANALYS =  5818.956  SECONDS
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15. Supplementary Notes

Langley Technical Monitor: William P. Henderson

16. Abstract

In this report, the usage of a transonic airfoil code for analysis, inverse design, and direct optimization of an airfoil immersed in propfan slipstream is described. For a detailed description of the theory, Reference 1 should be consulted.

In the following, a summary of the theoretical method, program capabilities, input format, output variables, and program execution are described. Input data of sample test cases and the corresponding output are given.

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